RMP Technical Review Committee Meeting

June 17th, 2014
San Francisco Estuary Institute
4911 Central Ave, Richmond
10:00 am - 3:00 pm

1.	**Introductions and Approval of Agenda and Minutes** (Attachment) Introductions, approval of minutes/ agenda and review of action items.	10:00 Bridgette DeShields
2.	**Information: Steering Committee Report (**Attachment) The Steering Committee met in April to discuss communications strategy, nutrients, program review, and Pulse and Annual Meeting.	10:20 Jay Davis
3.	**Action: Recommendation for Special Studies for 2015** (Attachments) The following proposals have been recommended by the workgroups or have been identified as priorities by the Steering Committee. The TRC needs to recommend a package of studies for 2014. 1. CEC Monitoring in Effluents (Sutton) 2. Monitoring CUPs in Napa River/ North Bay (Willis-Norton) 3. Monitoring Microplastics (Willis-Norton) 4. Small tributaries storm water wet weather characterization (McKee) 5. Regional watershed spreadsheet model (RWSM) year 5 (McKee) 6. Watershed loadings trends support (McKee) 7. Small tributaries loading strategy (STLS) coordination support (McKee) 8. Nutrient Modeling (Senn and Yee) 9. Moored sensor program continuation (Senn and Novick) 10. Nutrient science program coordination (Senn and Novick) 11. Monitoring program development (Senn and Novick) 12. SQO Analysis of Pacific Dry Dock (Willis-Norton) 13. Dioxin Synthesis (Yee) 14. Selenium in White Sturgeon Muscle Plugs (Davis) 15. South Bay Selenium Synthesis (Davis) 16. Selenium Data Compilation and Literature Review (Davis) 17. PCBs: Priority Margin Unit Conceptual Model Development and Monitoring (Davis) **Desired Outcome:** TRC recommendation on a package of studies.	10:40 Jay Davis, Rebecca Sutton, Lester McKee, Dave Senn
	Lunch Break	12:15

4.	**Action: Mesohaline Year 2 Funding** (Attachments) SCCWRP has completed the first Phase of the Mesohaline work. Based on a recommendation from the Exposure and Effects Workgroup, a revised proposal has been prepared for the Year 2 work Funding in 2013/2012 has been set aside for the Year 2 work ($90,500); however, the revised proposal is for $106,200. **Desired outcome**: Decision on whether to release Year 2 funding and to tap reserve funds for the additional $16K difference between the set aside and the revised proposal.	12:45 Jay Davis, Karen Taberski
5.	**Information: Update on Changes to S&T** (Attachment) The final plan for reductions to open Bay S&T monitoring will be summarized. An update on the planning for margins sampling will be provided, including a timeline for completing the planning process.	1:15 Jay Davis, Don Yee
6.	**Action: Re-Analyzing Sediment Samples** (Attachment) As presented at the December and March meeting, an issue was identified with the sediment organic analyses for 2004 through 2006. Results from re-analysis of all contaminant categories for select sites are now available and will be summarized. A decision is needed on how to qualify these results and whether to present them in RMP reports (e.g., RMP Update and the Pulse). RMP staff will provide a recommendation on the re-analysis of all sediments for these years. **Desired outcome:** Approve recommendation for sediment re-analysis.	1:45 Don Yee
7.	**Discussion: RMP Update and RMP Annual Meeting** The text for the RMP Update will be distributed for review by June 10. Feedback on the text will be solicited from the Committee. The RMP Annual Meeting will be held at David Brower Center. The latest draft agenda will be reviewed. **Desired outcome:** Feedback on RMP Update text.	2:15 Jay Davis
8.	**Information: Update on Workgroups and Scorecard** (Attachment)	2:40 Jay Davis
9.	**Action: Set date for next meeting and Plus/Delta**	2:55 Chair
	Adjourn	3:00

RMP
Technical Review Committee
March 25th, 2014
San Francisco Estuary Institute
Meeting Summary

Attendees

Bridgette DeShields, Arcadis/WSPA
Ian Wren, San Francisco Baykeeper
Karen Taberski, SF RWQCB
Rod Miller, SFPUC
Eric Dunlavey, City of San Jose
Nirmela Arsem, EBMUD
Meg Sedlak, SFEI
Jay Davis, SFEI
David Senn, SFEI
Jim Kelly, SFEI
Don Yee, SFEI
Ellen Willis-Norton, SFEI

Call In

Tom Hall, EOA, Inc. (South Bay Dischargers)
Robert Lawrence, US Army Corps of Engineers

I. Introductions and Approval of Agenda and Minutes [Bridgette DeShields]

Meg Sedlak opened the meeting by stating that the agenda item "Decision, Information: Proposals for Additions in Status and Trends" has been postponed until more TRC members are available to participate in the discussion. Meg scheduled a WebEx conference call to discuss margins sampling. Bridgette DeShields asked if all members were in favor of approving the previous TRC summary, and the summary was unanimously approved.

II. Information: Steering Committee Report [Meg Sedlak]

Meg Sedlak informed the TRC that Allied Defense Recycling was subject to enforcement action and ended after the RMP received a check from them for $40,000. Dyan Whyte of the WB was essential in helping obtain the funds. Meg stated that at the January meeting the SC discussed the pros and cons of combining the RMP Annual Meeting with the State of the Estuary Conference. The SC agreed that merging the two meetings was valuable because of the visibility the RMP received, increased attendance, and the collaboration eliminated the potential for overlap between meeting content and materials. Rod Miller noted that the registration process could have been smoother. Other topics of discussion included the RMP's communication strategy, the formation of a Selenium Strategy Team, and membership in the SC, TRC, and RMP workgroups.

III. Information: Update on Nutrients [Dave Senn]

David Senn provided the TRC with an update on nutrient modeling efforts. Three meetings were held with the nutrient technical advisors in 2013 and the result was the completion of a high level modeling plan. Dave stated that the model would be a resource to the community, with

researchers being able to use the base hydrodynamic model to work on their specific nutrient, or other contaminant, project. Any improvements made to the model would be shared with SFEI.

Dave then summarized the discussion and outcomes of the modeling workplan meeting held on January 16 and 17 at SFEI. The goal of the meeting was to clarify the science questions that the model was going to answer. There were three categories of science questions: 1) basic processes, 2) changes and future conditions, and 3) contribution of anthropogenic nutrients to current conditions. Dave then provided a list of 16 science questions that fall within the three categories. He stated that the technical advisors need to determine if the model platform can answer all of the scientific questions. For example, Dave is unsure questions about phytoplankton community composition can be answered easily with the model platform; a Darwin mode approach may need to be used which takes a lot of computational energy. The TRC agreed that the model should start basic and various dimensions (e.g. a longitudinal axis) should be added over time to ask increasingly complex questions.

Dave informed the TRC that the RMP proposed to move forward with the Delft modeling platform. USGS has already begun developing a hydrodynamic model for the Bay-Delta, CASCaDE, using the Delft platform; USGS has agreed to partner with the RMP to complete the model. Dave then listed the timeline for the modeling effort; year one will include model set-up, year two will focus on Lower South Bay and South Bay's ecosystem response; year three will include Suisun Bay's ecosystem response, year four will be full Bay modeling, and year five will focus on phytoplankton community composition. Dave stated that the model will not include the margin areas. Once the model is functional, the various parameters can be adjusted to evaluate the ecosystem response. For example, if clams are removed from the model, can the increase in phytoplankton biomass be explained?

Dave then presented the budget for the model. Hydrodynamic modeling will cost $100,000 per year, water quality modeling will cost $300,000, the technical team will require $60,000 in funding, and the consulting firm Deltares who will provide scientific expertise on a as-needed basis will cost $60,000 a year. Dave noted that a full-time water quality modeler will be hired during the development process. The full budget proposal will be brought to TRC in June for approval.

<u>Discussion:</u>
Karen Taberski asked why the focus was on South Bay even for answering questions about basic processes. Dave replied that the focus will be on the entire Bay for the basic processes questions. He noted that South Bay is interesting because there has not been a large drop off in chlorophyll concentrations, as there as been in North Bay; the change in chlorophyll has been more gradual in South Bay. Tom Hall responded that there are two different phenomenon occurring in North and South Bay that need to be distinguished. In North Bay, there is ammonia toxicity and the inhibition of phytoplankton growth, while in Lower South Bay there is classic eutrophication.

Karen Taberski asked if year one refers to 2014; Dave replied that year one will begin in 2014, but the years do not follow the calendar year. Rod Miller asked if the SFB RWQCB is helping prioritize the science questions. He was concerned that nutrient regulation will precede the science. Dave responded that it is possible to focus on source attribution in the earlier stages of

the modeling process; however, it may not be the most efficient way of reaching the goals of the model. Dave added that a Nutrient Steering Committee has been formed to ensure that the regulatory priorities are addressed. Jim Kelly stated that he is unsure if the Nutrient SC is well suited to address the regulatory priorities. Dave responded that there could be a group in-between the Nutrient SC and the Nutrient Science Team that addresses stakeholder concerns.

Ian Wren asked what portion of the RMP Nutrient funds will be dedicated to the modeling effort. Jay responded that the RMP will dedicate approximately $350,000 for year one of the modeling effort and the balance will be provided by the Nutrient SC. In future years, there will be a shift in funding so the RMP is not providing the majority of the funding.

Action Items:

1. Dave Senn will send the TRC the spreadsheet that details the nutrient modeling timeline and deliverables

IV. Discussion: Update on "Pulse Lite" and Annual Meeting [Jay Davis]

RMP Update

Jay Davis indicated that the 2014 RMP Update (Pulse Lite) will cost less to produce than in 2012 because there will befewer articles . The Update will include program highlights, program area updates, and trends at a glance. Jay listed some possible RMP activities and accomplishments that the program highlight section can include such as the completion of the PCB Synthesis; work on Contaminants of Emerging Concerns; the completion of the PBDE synthesis and manuscript; Meg Sedlak's article on PFOS in Bay biota; the outcomes of the methylmercury forum; and refinements to the Status and Trends program.

Jay stated that a draft of the Update will be sent to the TRC and SC by May 30th, 2014 and reviewer comments will be due by June 20th. The draft laid-out version will be sent to reviewers on August 8, comments will be due August 15, and the RMP Update will be printed on September 26.

Discussion:

Karen Taberski asked about the total cost for producing the RMP Update; Meg responded that it will cost around $50,000. Rod Miller wondered if the RMP Update should include a section on the impact of the California drought. Meg Sedlak responded that the topic could be a topic for a panel discussion at the RMP Annual Meeting. RMP stakeholders could discuss the financial implications, conservation efforts, and plans for the future. Eric Dunlavey noted that WWTPs have implemented water efficiency efforts for the past 15 years; even as the population grows, less water is used. Ian Wren stated that the discussion could be tied into other RMP work, such as how the drought will impact nutrient concentrations. Meg suggested asking Felicia Marcus to be involved in the Panel. Karen Taberski recommended that someone from the Department of Water Resources give an introductory presentation.

RMP Annual Meeting

Jay stated that the SC was interested designating blocks of time during the Annual Meeting for the RMP program areas. Possible program areas to include on the agenda are Status and Trends, Small Tributaries Loading, Nutrients, and Contaminants of Emerging Concern. Jay noted that

one of the topics would need to be removed from the schedule if a panel on the drought was added. Other possible topics include new monitoring programs the RMP is overseeing around the state (Delta and the Klamath Basin) or the RMP's updated communication strategy.

Discussion:
Bridgette DeShields asked Jay when the agenda would be finalized; Jay responded May 6th. Bridgette stated that the TRC should take the draft agenda to their agencies and ask for input. Jay and Meg agreed that TRC members should send ideas for outside speakers if they are relevant; however, the majority of the speakers would be SFEI staff and RMP workgroup panelists.

Action Items:

2. TRC members will send Jay Davis input on the draft RMP Annual Meeting agenda.

V. Information: Update on Selenium Strategy [Jay Davis]
Jay Davis stated that the SC discussed forming a Selenium (Se) Strategy Team and whether the team would be charged with gathering consensus on Se thresholds or with managing a smaller effort focused on identifying data gaps. The SC agreed that the smaller effort would most likely reach their goals. Bridgette DeShields stated that the Se Strategy Team will first work on identifying and reducing data gaps. If the first goal is achieved, more experts can join the team and work toward gathering consensus. The team will meet in April or May to discuss potential studies and the Strategy will be completed by October.

Discussion:
Bridgette stated that the data obtained from the team's monitoring studies may be useful for future adaptive management actions or the implementation of the TMDL.

VI. Information: Update on Reanalysis by EBMUD of Organics in Sediment
Don Yee reminded the TRC of the perceived dip in PCB concentrations from 2004 to 2006. He informed the TRC that EBMUD's reanalysis of the PCB samples indicated that the low bias was due to a change in the drying methodology. EBMUD subsequently offered to also reanalyze pesticide, PAH, and PBDE samples from 2005, 2006, 2007, 2011, and 2012 to determine if the low bias was evident in other organic contaminants. The same low bias was identified for total pesticides in 2005 and 2006; the concentrations were two to four times higher when reanalyzed. The low bias in PAH concentrations in 2005 to 2006 was not as significant, with concentrations 20 to 70% higher once reanalyzed. For alkylated PAHs the low bias was similar to that of pesticides, the reanalyzed 2005 and 2006 concentrations were two to three times higher.

Don stated that the RMP has learned that typical QC samples may not show inter-lab/inter-year differences. Therefore, in future years some samples will be retained for inter-year verification. Don asked if the TRC would recommend taking the same action as they did with PCBs, removing the 2004 to 2006 pesticide and PAH numbers from CD3, with a footnote stating that the data is available on request. Meg Sedlak replied that the RMP is waiting for the reanalyzed PBDE data from EBMUD; once all of the data is available she will send the results to the TRC and ask for their input.

Action Items:

3. Meg Sedlak will ask for guidance from TRC at next meeting on EBMUD reanalysis.

VII. Action: Recommendation for Reductions in Status and Trends [Don Yee, Meg Sedlak, Jay Davis]

Water

Meg Sedlak began the discussion on possible reductions to the S&T program by stating that the RMP will be out on the water every two years to measure copper and cyanide for the Site Specific Objective, selenium for the TMDL, and ancillary parameters. Every eight years the RMP will monitor for PCBs, PAHs, pesticides, Hg, and MeHg. Don Yee noted that for copper, with 10 to 15 samples 100% power can be achieved, but the RMP needs to decide the appropriate time frame for obtaining the 10 samples. If copper was sampled on a four-year cycle, then 100% power would not be achieved for eight years, which the group has decided is too long a time frame.

Meg asked whether MeHg should be sampled biennially since the RMP will already be out on the Bay. She noted that there is value in understanding MeHg cycling and trends, but that there will be a slight cost for sampling.

Discussion:

Eric Dunlavey asked why 1 ug/L copper difference was chosen as the standard for the power analysis. Meg Sedlak stated that it was included in the Basin Plan, but that she will confirm after the meeting. Jay stated that there was value biennially sampling MeHg because the Baywide MeHg average appears to have decreased since 2006 and it would be useful to determine if the trend continued. Karen Taberski stated that the benefit of sampling exceeded the costs. Eric asked the cost of MeHg analyses; Meg replied that the analytical cost was approximately $175.

Bridgette noted that by switching to a four-year sampling cycle, there would not be many analytes sampled during the wet season. Meg replied that it is worth thinking about changing the design to sample metals during the wet season.

Sediment

The proposed S&T design includes decreasing the number of dry season sediment samples to 27. Every four years PAHs, PCBs, Hg, and PBDEs will be sampled. Every eight years, metals, pesticides, benthos, and toxicity will be sampled. Meg asked the TRC if the program should continue to alternate wet and dry season sampling to catch the wet season phenomena. If the RMP continues to alternate wet/dry season sampling, there may be reduced power since there will be eight years in-between sampling during the same season.

Discussion:

Rod Miller asked if the RMP would be able to catch an event, such as El Niño, that would affect contaminant concentrations or trends if sampling only occurred every four years. Meg stated that the RMP is flexible enough to mobilize a sampling effort if the stakeholders believe an event is worth capturing. Jay stated that there are contingency funds available for increased monitoring. Jay added that without annual data the RMP will be unable to tell if the concentrations during the event are unusual. However, Jay stated that there are diminishing returns for obtaining the same data annually and the funds could be directed to other priorities.

Ian Wren asked if the RMP was confident that monitoring Se every four years in sediment was sufficient; Meg replied that Se is typically measured in water and sportfish and that the RMP will monitor Se biennially in water. Karen stated that she will ask Barbara Baginska if she is okay with sampling Se at a lower frequency in sediment.

Karen stated that wet season sampling mainly occurred to sample toxicity; however, toxicity will only be sampled during the dry season based on this new design. Meg asked if benthos, toxicity, metals, and pesticides should be sampled in 2018. Karen responded that toxicity should be sampled in 2018, but benthos should only be sampled during the dry season. Bridgette DeShields stated that if toxicity is also sampled during the dry season alongside metals and pesticides, then all the sediment analytes will be sampled every four years. Jay replied that instead of sampling metals and pesticides initially, some of the sediment sample could be archived. If there are high toxicity hits, metals and pesticide concentrations could be analyzed.

Don Yee suggested removing benthos sampling from the S&T program until the results from the analyses become clearer. Karen replied that benthos could be sampled during the dry season only at stations where an appropriate index is available.

Action Items:

4. Karen Taberski will ask Barbara Baginska if she is okay with sampling Selenium at a lower frequency in sediment.

Bivalves

The new S&T design includes a reduction in the number of bivalve sampling sites from 11 to six. PAHs will be sampled every two years and every four years PCBs, PBDEs, metals, and pesticides will be sampled. Jay noted that there is no clear trend for PAH concentrations in bivalves; however, bivalves are the ideal matrix for PAH monitoring because they don't metabolize PAHs. If the RMP sampled biennially, CEC concentrations could also be monitored. Additionally, it would take 26 years to get to 80% power for PAHs if bivalve sampling occurred every four years. Karen stated that she would support continuing the biennial sampling of bivalves.

VIII. Information: Update on the 2014 Special Study Evaluating Effects of Particle side? Shape on Amphipod Toxicity [Meg Sedlak]

Meg Sedlak informed the TRC that there is reduced funding for the 2014 special study on amphipod toxicity. The State Water Board is providing $25,000 rather than $50,000 from the Southern California Coastal Water Research Project. To account for the decrease, toxicity will only be compared against clay concentration; previously the effect of clay, lipid content, and particle size was going to be analyzed. Karen Taberski noted that if the RMP is interested, lipid content could be analyzed as part of a 2015 special study.

IX. Information: Update on Workgroups and Scorecard [Meg Sedlak]

Meg Sedlak reviewed the RMP's worgroup activities. She stated that the Nutrient Conceptual Model and coring manuscript will be completed by April 2014. The Sources, Pathways, and Loadings Workgroup will be holding their next meeting on May 29. The Exposure and Effects Workgroup will check in this year to decide how to support the SFB RWQCB's need to collect sediment data from 303(d) listed hotspots in the Bay. The SFB RWQCB is interested in seeing some Bay hotspots can be removed from the 303(d) list. The Emerging Contaminants Workgroup is meeting on April 15 to discuss the bioanalytical tools study and current use pesticide, effluent, microplastic, and alternative flame retardant monitoring. The Sportfish Workgroup recently met to discuss the 2014 summer sampling effort.

Jay Davis then updated the TRC on the Delta RMP. The Delta RMP Steering Committee recently picked four focus areas for which workgroups will be formed including Mercury, Nutrients, Pesticides, and Pathogens. Each workgroup is generating a monitoring program design, which the Delta RMP's Technical Review Committee will review and approve. Monitoring is expected to begin in late 2014 or early 2015. Karen Taberski asked about the funding mechanism; Jay replied that before funding is secured the Delta RMP wants to decide what studies they are interested in supporting.

Meg Sedlak ended the discussion by station that the RMP has been getting involved in monitoring in the Klamath River Watershed. The RMP recently hired Randy Turner who will serve as the Coordinator of the Klamath Basin Monitoring Program.

X. Action: Set date for next meeting and Plus/Delta [Bridgette DeShields]
The second quarter TRC meeting was scheduled for June 17, 2014.

RMP
Technical Review Committee
Margins Sampling Conference Call
April 10th, 2014
San Francisco Estuary Institute
Meeting Summary

Attendees

Bridgette DeShields, Arcadis/WSPA
Karen Taberski, SF RWQCB
Eric Dunlavey, City of San Jose
Tom Hall, EOA, Inc. (South Bay Dischargers)
Brian Anderson, UC Davis
Paul Salop, AMS
Chris Sommers, EOA, Inc. (BASMAA)
Naomi Feger, SFB RWQCB
Amy Chastain, AECOM/ SFPUC
Meg Sedlak, SFEI
Jay Davis, SFEI
Jim Kelly, SFEI
Don Yee, SFEI
Josh Collins, SFEI
Ellen Willis-Norton, SFEI

I. Meeting Goals [Meg Sedlak]

Meg Sedlak informed the TRC that with the proposed reductions in the S&T program, it is now possible to think of additions to the program such as monitoring in the margins.

II. Margins Ambient Sediment Data Needs [Don Yee]

Don Yee began the discussion on margins sampling by listing the three decisions that need to be made:

1. Do we need ambient margins monitoring?
2. Are there benefits to ambient margins data sooner/now?
3. What scope of effort should we start with?

The current S&T program does not sample margin areas, which are a significant portion of the Bay area for some subembayments (e.g., margin habitat is approximately 74% of Lower South Bay). Don indicated that margins ambient data are needed if the TRC considers margins as important habitat and if ambient margins data needs are higher than other priorities. Don stated that the RMP has collected a considerable amount of open Bay data and that margins represent a substantial data gap in our overall understanding of the Bay and Bay processes.

Don then reviewed the differences between ambient and targeted margins sampling. There are currently more data from margins hotspots than the ambient margins. Targeted sampling would be useful if there were planned control actions that had immediate data needs. However, ambient margin data would provide information on the status and trends of an important Bay habitat. Additionally, biota in the margin areas are spatial integrators; therefore, well-distributed ambient

data are needed to correlate water/sediment concentrations and tissue concentrations. Ambient margin data would also be useful for managing polluted sites because it could serve as a comparison to margin hotspots, it may reveal that a pollution source is more distributed than previously thought, or uncover new pollution sources. Finally, ambient margin data may reveal that the contaminant concentrations in dredged sediment may be higher than the ambient open Bay, but lower than the ambient margins; therefore, increased amounts of dredged sediment could be placed in the margins for re-use.

If the TRC agrees that the margins are important habitat, Don asked the members to consider the type of sediment data needed, the approach, location, and time frame for sampling. He noted that the costs per station would be higher than the open Bay because of logistics. Additionally, if the TRC agreed to substitute open Bay sampling sites for margin sites, the power to detect changes in the open Bay would decrease. A reduction of Bay sites to four per segment would result in a 5% power loss in all subembayments except for in Suisun; in Suisun the reduction in power would be greater because of the high variability in the subembayment.

III. Sampling Options [Don Yee]

Don then listed four possible options for margins sampling for the TRC to consider including 1) sampling all of the margins sites in one year as either a supplement or replacement to the Bay S&T program; 2) sampling all 40 sites within two to three events; 3) sampling the margins in five incremental efforts that would take five to 10 years to complete; and 4) sampling the same total number of S&T sites, but include margins sites based on the proportion of the area they cover in each subembayment. Don noted that an issue with the fourth option is Central Bay is only 4% margin habitat; therefore, approximately one margins site would be sampled every 10 years.

Sampling all 40 sites at once would cost on the order of $420,000. The benefits are that some statistical power would be available quickly and there would be no confounding of temporal and spatial variability. The cons are that the high cost and the possibility of overwhelming the laboratories the RMP uses for their analyses. Sampling within two to three years ($200,000 per year) would place a moderate load on the S&T laboratories and the confounding of temporal and spatial variability may be minimal if sampling occurs in a similar water year. Sampling 40 sites within 5 years ($100,000 annually) would place a small load on S&T laboratories, but the chance of there being similar water years for all five events is unlikely. Additionally, there would low statistical power at the beginning of the effort. If option four, proportional sampling, is chosen there would be no additional costs; however, there would very low power in the beginning of the effort and even more conflating of spatial and temporal variations. Don stated that he does not support the fourth option, especially if the TRC agreed to reductions to the S&T program to accommodate additional margins sampling.

<u>Discussion:</u>

Chris Sommers stated that he is worried that even with 40 sites the variability will extremely high and the RMP will not be able to make any conclusions about individual subembayments. Don responded that high variance should not discourage margins sampling as long as the RMP realizes that there will most likely be very high and low numbers within one year.

Josh Collins stated that Don's definition of the margin area includes marshlands. Josh and Don agreed that the sample should exclude any emerging vegetation to minimize overlap with other monitoring efforts occurring in the marshlands. Therefore, the margin areas would mainly include intertidal channels and mudflats.

Chris asked what the cost savings were from reductions in the S&T program. Jay Davis replied that the reductions would be approximately $150,000 for sediment, $15,000 for bivalves, and $30,000 for water annually. If ten margin sites were sampled every year over the next four years, the cost would be roughly equivalent to the cost savings from the new S&T design. Karen Taberski asked the cost savings if toxicity and benthos were excluded; Don replied that removing the two elements would cut costs by about 25%. Bridgette suggested initially only collecting chemistry data and adding toxicity and benthos sampling to the program if the need arose.

Naomi stated that the SFB RWQCB is supportive of collecting margins sediment data; Chris Sommers stated that he was also supportive of a margins sampling effort. However, Chris stated that it would be prudent to approach margins sampling as a pilot study. He recommended completing sampling within one to two years and the results may inform a new sampling design. Bridgette stated that the results may indicate that sampling the margins should become even more of a focus for the RMP. Don replied that Chris was suggesting option one, the more intensive sampling effort.

Tom Mumley stated that there was consensus among the TRC to conduct margins sampling. Naomi and Tom agreed that the SFB RWQCCB has an immediate need for margins data to make management decisions. He supported the collection of target and ambient margins data at the same time to resolve 303(d) listings, PCB listings, and restoration decisions in the margin areas. Tom stated that 10 years is too long to wait to obtain the data. He added that if the existing framework does not support a shorter time frame, then he is willing to reduce the number of open Bay samples to obtain the information. Chris wondered if the RMP could concentrate on certain Bay segments that were considered more important to reduce the sampling costs. Chris was concerned that 40 margin sites across the entire Bay would answer management questions. Chris added that some sites could be added to the design if the number of analytes sampled was reduced. Don replied that it was possible if the samples were archived, but that the RMP analyte list is already small and removing analytes will not result in considerable cost savings.

Meg Sedlak stated that it appeared the TRC was advocating for replacing the Bay S&T program for one year with an intensive margins sampling effort. Jay Davis replied that replacing the Bay S&T entirely may not be necessary, margins sampling could in addition to the Bay S&T effort. Josh Collins suggested connecting with the restoration community to determine their information needs. Josh added that the RMP completed a marsh and intertidal channel monitoring effort in North Bay a few years ago. He suggested examining the data to help inform the margins sampling effort. Naomi ended the discussion by proposing a margins sampling RMP workgroup to help develop the design.

<u>Action Items:</u>

1. Meg stated that based on the discussion today, the RMP will send the TRC a list of margins sampling design options with a more detailed description of costs.

Item 1: TRC Action Items Updated: Monday, June 02, 2014

Action Items - March 2014

#	Action Item	Who?	When?	Status
1	Dave Senn will send the TRC the spreadsheet that details the nutrient modeling timeline and deliverables.	David Senn		
2	TRC members will send Jay Davis input on the draft RMP Annual Meeting agenda.	TRC		
3	Meg Sedlak will ask for guidance from TRC at next meeting on EBMUD reanalysis.	Meg Sedlak		On agenda.
4	Karen Taberski will ask Barbara Baginska if she is okay with sampling Selenium at a lower frequency in sediment.	Karen Taberski		
5	Meg Sedlak will send the TRC a list of margins sampling design options with a more detailed description of costs.	Meg Sedlak		A brief discussion of margins is on the agneda. RMP staff are working on a margins sampling plan.

Action Items - December 2013

#	Action Item	Who?	When?	Status
2	Meg Sedlak and Jay Davis will prepare a proposal for the TRC that outlines options and associated cost estimates for reanalyzing 2005 organics data.	Meg Sedlak		Discussion on today's agenda.
7	Don Yee will conduct a power analysis to determine suitability of a reduction of Cu sample frequency.	Don Yee		

Item 1: TRC Action Items Updated: Monday, June 02, 2014

Action Items - June 2012

#	Action Item	Who?	When?	Status
1	Chris Sommers offered to provide examples of good reports for managers	Chris Sommers		
4	Clarify role of CFWG in providing oversight to modeling strategy	Jay Davis		

Action Items - March 2012

#	Action Item	Who?	When?	Status
2	Convene the mercury strategy team to discuss the next steps in the process of developing plans for mercury work	Jay Davis		Synthesis article accepted

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RMP Steering Committee Meeting

May 6th, 2014

San Francisco Estuary Institute

Draft Meeting Summary

Attendees:

Tom Mumley*, SFB RWQCB
Jim Ervin (City of San Jose)
Adam Olivieri, Stormwater (BASMAA/EOA Inc)
Karin North**, MediumPOTWs (City of Palo Alto)
Dan Tafolla, Small POTWs (Vallejo Sanitation and Flood Control District)
Peter Carroll, Refineries (Tesoro Golden Eagle Refinery)
Jay Davis (SFEI)
Jim Kelly (SFEI)
Meg Sedlak (SFEI)
Ellen Willis-Norton (SFEI)
Lawrence Leung (SFEI)
Tony Hale (SFEI)
David Senn (SFEI)

I. Approval of Agenda and Minutes [Tom Mumley]

Tom Mumley questioned the need for such detailed meeting summaries, stating that it may be enough to include key discussion pieces and a clear statement of what was agreed upon. Peter Carroll agreed stating that the Se Strategy Team summary was an example of a too detailed summary. Meg Sedlak stated that she would edit the Se Strategy Team summary in both the TRC and SC summaries and send them to Tom for approval. Tom suggested that the level of detail for meeting summaries should be included as part of the RMP's program review. Adam Olivieri suggested that Ellen Willis-Norton write the meeting summary in the same way as in the past and Tom and Adam will subsequently edit it to the appropriate length to be posted on the website.

Items to Approve:

Adam Olivieri motioned to approve the previous SC meeting summary with edits to the Se Strategy Team summary; Karin seconded and the summary was unanimously approved.

II. Committee Member Updates [Group]

Adam Olivieri stated that the State's Contaminants of Emerging Concern (CEC) expert panel met to discuss filling data gaps. He mentioned that the RMP may be able to request funds from the state to fill CEC data gaps in the Bay.

III. Information: TRC Meeting Summary [Meg Sedlak]
Jay Davis provided the SC an update on the Selenium Strategy. The first Se Strategy Team meeting was held on April 22 and had good participation and stakeholder representation. The focus of the Strategy will be on Se concentrations in sturgeon. Jay stated that the team recommended isotope analysis of the sturgeon muscle tissue to understand where the sturgeon are foraging. Tom noted that understanding the difference between North Bay and South Bay Se concentrations in sturgeon will be valuable for the TMDL's implementation.

The RMP's 2014 sport fish sampling effort will also collect muscle plugs as well as muscle fillets to develop a correlation between the concentrations. Once a relationship is established, the RMP can join the CA Department of Fish and Wildlife's sturgeon population sampling cruises and collect muscle plugs, increasing the sturgeon sample size. Ideally, sturgeon eggs will also be collected because they are the most sensitive to Se contamination; however, the team is unlikely to find gravid females. The Se Strategy Team stated they are interested in SFEI being the repository for Se data. The next Se Strategy Team meeting will be held on June 3.

IV. Action: Update on 2014 Budget [Lawrence Leung, Jen Hunt, Jay Davis]
Lawrence Leung stated that the RMP identified a new participant, the Treasure Island Wastewater Treatment facility. Five invoices were sent to them for Water Year (WY) 2010 through 2014 and the funds will be added to the reserve. Treasure Island will be included in future years' POTWs starting in WY2015 and will contribute $5,000 a year. Karin North noted that the Treasure Island facility is also becoming a BACWA member.

Lawrence stated that 87% of the participant fees have been received for 2014 and that all invoices will be in by May. The America's Cup mitigation fees have also been received. Lawrence noted that there is $12,000 in interest for 2014, but only $2,169 was received in Q1; therefore, the interest budget may need to be lower. Allied Defense Recycling (ADR) paid $40,000 of their $45,000 in fees. Therefore, the $5,000 will be taken out of the dredger reserve. Tom Mumley noted that Dyan Whyte deserves the majority of the credit for ADR paying their fees.

Lawrence requested an extension of the 2013 labor budget from June 2014 to September 2014. Meg Sedlak stated that the additional time will be used to complete work associated with nutrient studies, modeling efforts, the mesohaline study, and bioanalytical tools study. Tom noted that the SC has still not decided if the second year of the study to develop benthic indices for the mesohaline environment will be funded. Meg agreed, stating that the second year of the mesohaline study is earmarked at $90,000, but the SC can decide in July whether they would rather put the $90,000 back into the RMP reserve.

Lawrence stated that SFEI is changing from a calendar year to the State's fiscal year in July 2014. Tom Mumley asked if the RMP should also consider moving to the fiscal year. Meg replied that she would like to reflect and check-in during the July SC meeting.

<u>Items for Approval:</u>
Adam Olivieri motioned to approve the extension of the 2013 labor budget to September 2014. Karin North seconded the motion and the extension was unanimously approved.

Karin North motioned to approve additional funding for Selenium in sportfish work for 2014, which will cost $10,680. Adam seconded the motion and the additional funding was unanimously approved.

The third item for approval was reallocate the remaining 2013 and 2014 Event Mean Concentration (EMC) funds; the unexpended funds would be used to synthesize monitoring information collected to date. Meg stated that the Small Tributaries Loading Strategy strongly supported the reallocation. The team is only requesting $58,000 of the $90,000 available for EMC development; the remaining funds will enter the reserve. Adam and Tom agreed that the remaining funds should not enter the reserve, but remain as unencumbered funds within the project. Adam motioned to approve the reallocation, Dan Tafolla seconded, and the reallocation was unanimously approved.

Action Items:

1. Meg Sedlak will add a check-in about the RMP switching to a fiscal year at the July SC meeting.

V. Decision: Communications Strategy – Part II [Jay Davis]

RMP Communications Strategy

Tom Mumley stated that he thought the purpose of the agenda item was to outline the RMP's communication strategy and how the communications portfolio achieves the strategy. Tom added that the communication products should match the mission and goals of the RMP. Karin North noted that the RMP's communications strategy should fit into SFEI's communication strategy.

Tony Hale stated that SFEI has contracted a communications consultant, the Kos-Read Group, to 1) increase funding, 2) encourage effective policy, and 3) increase recognition of SFEI. The official communications plan, which will have embedded in it a communications strategy, will be rolled-out this May. To start addressing SFEI's communications goals staff are creating an institutional one-pager that details what SFEI does; the SFEI webpage is changing; and a quarterly newsletter that features the RMP will be created. Karin North asked the cost of the consultant; Tony responded the Kos-Read Group is under a $15,000 contract.

Tom Mumley stated that the RMP communications strategy should be focused on informing people who have an interest in Water Board decisions. He stated that it was unclear what use informing the general public was and stated that it would require considerable funding. Jay replied that the RMP has had discussions on who they are trying to reach, primarily RMP participants.

Tom asked if it is in the RMP's interest that other researchers studying and monitoring the Bay know about the RMP. He stated that the RMP has not reached out to that audience and that there may be the potential for collaboration.

RMP One-Pager

Karin stated that it would be useful to develop a one-pager about the RMP to give to new staff members from agencies that are RMP participants. Tom stated that the one-pager should make

clear that dischargers would need to individually monitor their receiving waters without the RMP, which costs more money than contributing to the RMP. Peter Carroll thought that the one-pager should focus on different aspects of the RMP depending on the type of participant it is given to. Karin and Adam Olivieri agreed that a standard one-pager would be sufficient.

Current RMP Communication Products
Jay Davis quickly ran through the RMP's current communications products including:

1. Pulse
2. Estuary News articles
3. RMP Web Site
4. RMP Update
5. Technical Reports
6. Journal Publications
7. Annual Meeting
8. Email Updates NEW
9. SFEI Newsletter NEW
10. Social Media NEW
11. Annual Monitoring Results
12. Invited Presentations
13. Workshops
14. Fact Sheets
15. Seminars/Webinars
16. Estuary Portal
17. State of the Estuary Report

Jay stated that The Pulse of the Bay is the central part of the RMP's communication strategy. Jay stated that the RMP Update will be turned into an e-book this year and if successful the same will be done with the Pulse. Tom asked that Jay revisit pursuing a 2015 Pulse of the Bay at the July SC meeting since a State of the Bay report may be produced simultaneously.

Jay stated that the next round of the Estuary Newsletter is coming out in June. He proposed that the article focus on the Small Tributaries integrated Report. Tom stated that he was concerned about being able to gather the material in time; Jay replied that RMP staff outline the article, but the SFEP staff writes the article and conducts the interviews. Adam stated that he would provide Jay with names of people to interview for the article. Jay suggested that the themes for each quarterly newsletter be recycled (e.g., every September the article would be about PCBs). The schedule would be as follows:

1. June – Small Tributaries Loading
2. September – PCBs
3. December – CECs
4. March – Nutrients

Meg stated that other studies would be interesting to highlight in the Newsletter, such as Copper and the olfactory nerve in salmon. Tom also liked the idea of having Copper as the issue for the September article; the SC agreed that Copper instead of PCBs should be the focus of the article.

Jay stated that the RMP web site is also being updated, including the Contaminant Data Display & Download page, with funding from the State Board. Jay noted that he will continue his presentation of RMP communication products at the next SC meeting and will also provide the SC with a draft communications strategy. Karin and Peter Carroll volunteered to help Jay with the strategy.

RMP Update E-Book
Tony Hale reviewed plans for turning the RMP Updated into an e-book. The benefits of an e-book are that documents outside of the Update can be linked to pages within the e-book, pages within the e-book itself can be linked to, and analytics for what people are reading will be available. Additionally, the data can be disaggregated in interactive graphics allowing the reader to interact with the data in new ways. The software is open source and works on any browser that uses html5. Tony noted that a regular pdf version will also be available

The total cost of the e-book is $50,000. The cost of building the infrastructure is $15,000, the interactive design costs $6,000, the interactive maps and charts cost $8,000 each, video footage to add to the e-book would cost $10,000, and social media promotion would be $3,000. Creating the first e-book would cost more than subsequent e-books. Karin noted that with the creation of an e-book the cost of the RMP Update would be similar to that of the Pulse of the Bay. Tony replied that the video portion of the e-book could be removed. Adam asked if the printing costs could be cut be reducing the number of hard copies. Jay replied that all of the hard copies of the Pulse Lite were distributed in 2012.

Tom stated that the videos would not impact management decisions. Jay and Jim Ervin replied that it may get more managers to look at the documents or inform stakeholders who don't know about the sampling process. Meg Sedlak added that it may interest the public. Tom stated that he finds adding more interactive charts as a better way to spend the funds than a video. However, he agreed with Jay and Karin that the video could be a pilot to see if the graphs or the video was more popular.

Tom stated that the funds would have to be taken from the reserve, but he thinks the e-book is a worthwhile investment because it may make a big impact in how the RMP communicates. Meg asked Tony if he could have the e-book ready by the Annual Meeting if the graphics are sent to him in advance; Tony replied affirmatively.

<u>Items to Approve:</u>
Karin North motioned to approve the creation of the e-book, Jim Ervin seconded, and the e-book for the RMP update was unanimously approved.

<u>Action Items:</u>

2. Jay Davis will revisit pursuing a 2015 Pulse of the Bay at the July SC meeting.
3. Adam Olivieri will send Jay Davis names of people to interview for the Small Tributaries Integrated Report article in the Estuary Newsletter.
4. Jay Davis, Karin North, and Peter Carroll will draft a RMP Communications Strategy before the July SC meeting.

5. Jay Davis will email the SC the SurveyMonkey results from the RMP Annual Meeting.

VI. Decision: Optimizing S&T and Request for Funding Margins Planning [Meg Sedlak]

Optimizing S&T

Meg Sedlak stated that the goals for the agenda item where to confirm changes to the S&T program and decide whether to include margins sampling. In water copper and cyanide will still be sampled biennially because they have site specific objectives. Selenium will also be sampled because of the upcoming TMDL as well as meHg and ancillary parameters. Every eight years PCBs, PAHs, Pesticides, and total Hg will be sampled. PBDEs will no longer be analyzed in water.

In sediment, the number of sites is dropping from 47 to 27 in the dry season. Sediment would be sampled on a four-year rather than two-year cycle. Every four years meHg, toxicity, PBDEs, and ancillary parameter will be measured. Every eight years PAHs, PCBs, Hg, other metals, Se/Ar, pesticides, and benthos will be measured. Meg noted that she needs to confirm with Brian Anderson and Beth Christian that sampling PAHs, PCBs, and Hg on an eight year cycle is acceptable. Tom asked why PBDEs and toxicity would be sampled more frequently. Meg replied that the RMP wanted to sample toxicity every four years to sample during both the dry and wet season and that the RMP wanted to catch the decline in PBDEs. Tom and Meg agreed that meHg and Hg should be sampled together.

The revised S&T includes reducing the number of bivalve stations from 11 to six. Every two years PAHs and PBDEs will be sampled. Every four years PCBs will be sampled to continue to monitor the concentration decline. Legacy pesticides and metals will no longer be sampled in bivalves. The RMP is still deciding how often to include CEC and Se sampling.

Margins Sampling

Meg Sedlak noted that margins sampling is being considered in parallel with changes to the S&T program. The recommendation from the TRC was to monitor the margins biennially at 20 sites starting in 2015. The RMP is requesting $20,000 from the reserve to begin planning for margins sampling.

Tom Mumley stated that the TRC did not make a formal recommendation to monitor 20 sites biennially. The group decided that sampling should at least consider 20 sites biennially, but wanted to consider sampling more sites and/or more frequently. Meg replied that she will come back to the SC in July with a more detailed margins sampling plan. Tom noted that the margins area is larger than the one in the map Meg presented because the RMP cannot reach some of the stations that are included in the current sampling plan. Jay stated that the RMP can map areas that they have not been able to sample.

Peter Carroll asked if the RMP is fulfilling its mission of running a baseline program of monitoring trace substances in the Bay. Tom replied affirmatively, the new S&T program does not violate the RMP's MOU. Now that the RMP has learned about the Bay proper, it is time to begin understanding the concentrations in the Bay margins.

Items to Approve:
Jim Ervin motioned to approve moving $20,000 from the reserve to being margins sampling planning and to reduce the number of sediment stations from 47 to 27 in the dry season, Dan Tafolla seconded and the motion was unanimously approved.

Action Items:

6. Meg Sedlak will come back to the SC in July with a more detailed margins sampling plan.
7. RMP staff will map stations that they have had to skip sampling during the current S&T program.

VII. Action Program review [Dave Ceppos]
Before the Dave Ceppos presentation, Jim Ervin asked if the RMP will need to evolve and begin to look directly at beneficial uses of the Bay (e.g., simple presence/absence of fish and other species). Meg Sedlak replied that the RMP works with partners who look at other beneficial uses such as CDFW and USGS and piggy-backs on their studies. Tom Mumley replied that the RMP has typically been pollutant centered and thinks that looking at other indicators of Bay health may be beyond the current scope and program review. However, Tom stated that Jim's point was valid and the RMP should begin thinking about how it will evolve. Tom stated that the work on nutrients has made the RMP think about and understand the entire Bay ecosystem.

Meg began the discussion on the MOU by stating that Jim Kelly found that there were discrepancies between what the RMP MOU said the RMP was doing and what it actually was accomplishing. Therefore, the RMP is getting ready to amend the MOU and would like to take a detailed look at the MOU and determine what new information needs to be articulated. Dave Ceppos, Center for Collaborative Policy (CCP) at the California State University Sacramento, presented a proposal to complete a $125,000 RMP program review. Tom noted that the goal of the program review was to generate clear foundational documents for the RMP.

Dave Ceppos stated that the program review will be an opportunity to check on the status and management of the RMP in a confidential manner. RMP stakeholders will be asked about the RMP's strengths and weaknesses. Based on the information obtained during the interviews Dave and his team will come forward and develop recommendations for the RMP. He noted that he is sensitive to the fact that the RMP is an established program that is successful and will not develop a governance tool that shifts the groups tone. Dave added that he has staff that specializes in water quality that will be assigned to the RMP.

Discussion:
Peter Caroll noted that Dave Ceppos' proposal includes preparing a draft charter and asked if that is necessary. Dave responded that it is up to the RMP; the charter will lay out a more defined structure and will help answer questions like who is a member, what happens if a member is not attending, or how to replace a member. Tom added that the charter could be a package of documents or a living document. Dave replied that the type of product depends on the objective of the program review.

Tom stated that it would be useful to document how the RMP has done business and reflect on how it could be done better. He noted that the program review will also need to include reviewing SFEI's role in context of the RMP since the RMP is a fundamental reason the institute exists. As SFEI grows, the funds allocated to the RMP have not changed.

Peter asked how detailed the minutes of the various meetings have to be; Dave replied that Peter's question was a legal counsel question, but he stated that an elected body can hold a closed door session and maybe the RMP could agree to something similar.

Karin North asked if Dave will also look at RMP workgroups; Dave replied that he will not look at them in detail. Adam Olivieri noted that workgroups are an essential part of the program that help decide what special studies move forward to the SC. Adam replied that interviewing 20 RMP participants should cover the SC, TRC, and the workgroups and strategy teams. Tom stated that direct participants, institute staff, other participating stakeholders (e.g., EPA and Baykeeper), and the science advisors should be included in the interviews.

Dave responded that he can address the workgroups, but it may increase the fees of the program review. Tom stated that he was in support of allocating more funds to the review if there is value in digging deeper. He noted that it would be useful to review who is leading the workgroups since the scientists are often running the workgroup and brining content forward. Tom stated that the RMP's response to a former science advisor's critique of the workgroups would be a useful document to share with Dave since it explains how the workgroups conduct their business.

Jay Davis stated that even though many procedures aren't documented, the RMP does follow specific procedures. He stated that he will write down and share the RMP procedures with Dave. He will also share the names of the SC, TRC, and workgroup and strategy team members. Jay was unsure he could complete the tasks by the next SC meeting. Jim Kelly said he could start it with Phil Trowbridge, the new RMP Program Manager and give it to Jay to review. Meg suggested that Jim Kelly sit on a committee with Tom and Jay to help move the program review forward.

The SC agreed to move forward with the program review and approved of the scope of work Dave provided. He noted that the scope of work can change during the process with the SC's approval. Karin North suggested that the three-person committee could allocate $48,000 to the program review without needing the SC's approval, as long as SFEI and the Water Board approved of the allocation.

Items to Approve:

Karin North motioned to approve the ability of the RMP to allocate $48,000 to the program review without coming back to the SC, Peter Carroll seconded the motion, and the motion was unanimously approved.

Action Items:

8. Jim Kelly and Phil Trowbridge will write down and share the RMP procedures with Jay Davis.

VIII. Update on Annual Meeting 2014 and "Pulse Lite" [Jay Davis]

RMP Annual Meeting

The RMP Annual Meeting will have four sections:

1. *Status and Trends*: Barbara Baginska will present on Selenium, Jay Davis on PCBs, and Don Yee on the revised S&T program.
2. *Small Tributary Loads*: Chris Sommers will present on the integrated stormwater monitoring report, Lester Mckee or Alicia Gilbreath will present on the STLS strategy Phase 2, and Jing Wu or Lester will present on green infrastructure.
3. *Nutrients*: Dave Senn will provide a nutrient strategy update, Raph Kudela will present on algal toxins, and Emily Novick on moored sensor work
4. *Contaminants of Emerging Concern*: Becky Sutton will provide a CEC strategy update, Nancy Denslow will present on Bioanalytical tool development, and Ellen Willis-Norton on Fipronil.

Jay Davis stated that other potential talks include Anthony Malkassian presenting on historical nutrient data, Jim Cloern talking about phytoplankton assemblages in the Bay, Dan Schlenk providing a broader discussion on bioanalytical tools, or a Keith Maruya discussing the statewide CEC plan.

Discussion:

Tom Mumley asked why there wasn't a keynote speaker. Jay responded that without a keynote there was more time available for each section. Peter Carroll asked if there was much more information to present about the Small Tributaries Loading Strategy (STLS) or if the update at the last RMP Annual Meeting was sufficient. Jay stated that the talk would focus on Phase 2 of the STLS work. Karin North suggested that Richard Looker lead the Small Tributary Loads Discussion if Chris Sommers is a presenter.

Jim Ervin thought that green infrastructure did not fit in with the Small Tributary Loads section. Tom and peter that green infrastructure directly affects loadings to the Bay; Adam Olivieri added that if flow is minimized or eliminated then loads to the Bay are reduced. Adam supported having Matt Fabry present on green infrastructure.

Tom asked if there was enough data to report on the moored sensor work; Karin stated that the Dumbarton sensor has been out in the Bay for eight months. Jay stated that the moored sensor work could be included in Dave's presentation about the nutrient strategy and Anthony could talk about historic data monitoring and associated assessment framework.

Tom asked why Fipronil was being highlighted; he suggested a talk on current use pesticides and highlighting Fipronil as a pesticide of concern. Tom also noted that he did not support a talk on the statewide CEC plan. The group agreed that Jay and Naomi Feger could work together and decide on which speakers they would like to invite.

IX. Deliverables Update [Dave Senn, Meg Sedlak]

Nutrients Update

Moored Sensor

Dave Senn informed the SC that the moored sensor is running at the Dumbarton Bridge and the data correlates with the USGS data. He noted that a summary of year one results is due in May, but another update was accidentally scheduled for June 2014. Only one update will be generated and Dave asked if in the future the SC would like a six month or annual progress report. Jim Ervin stated that an annual update was adequate. Adam Olivieri asked if the materials used to brief BACWA could also be used to brief the RMP. Dave noted that now that the Nutrient SC has formed, moored sensor updates will no longer be sent through BACWA. Karin North suggested that the updates be sent to both the RMP SC and the Nutrient SC.

Modeling

Dave stated that the proposed collaboration with USGS on hydrodynamic and bloom models will begin in June 2014 alongside water quality modeling. Dave noted that at the nutrient modeling workplan meeting the focus was translating the science/management questions into modeling relevant questions. From there, a workplan can be developed. The major components of the workplan include 1) proceeding with the Deltares suite of models, 2) partnering with USGS to develop the base hydrodynamic model and basic biological model, and 3) the RMP will focus on the simple water quality models to have ready for the completion of the hydrodynamic model.

The nutrient modeling budget is current $270,000 for water quality modeling, $100,000 for the USGS collaboration, $65,000 for technical collaborators, and $65,000 for the Deltares models and support. The RMP has provided $400,000 to date, but funding will be shifting to the Nutrient SC.

Stormwater Technical Report

The final stormwater technical report is near completion and should be released by the end of May.

PCB Conceptual Model

Tom Mumley noted that the original due date of the PCB Conceptual Model Report was March 2012. The report is a critical project that needs to be completed. Jay Davis stated that it took a long time to receive comments and he has been booked since the comments came in. He is going to try to finalize the report by early June. Adam Olivieri asked Jay to pick a date when the final draft will be received, give the group two weeks to review, and then finalize.

Action Items:

9. Jay Davis will send Adam Olivieri and Tom Mumley the date when the final PCB Conceptual Model draft will be completed.

X. Set next meeting date and Agenda topics [Thomas Mumley]

Meg Sedlak is taking a year-long leave of absence after 10 years of incredible work for the RMP. Phil Trowbridge from the New Hampshire Department of the Environment will serve as the new RMP Program Manager.

Karin North suggested increasing the meeting time so the meeting ends on time. The group agreed to extend the time to 9:30-3:30 pm. The next SC meeting will be held on July 15, 2014 at 9:30 am.

Item # 3: 2015 special studies

	Proposed 2015 Studies	Cost
1	CEC in Effluent	$55,000
2	CUPs in Napa/North Bay	$55,000
3	Microplastics	$9,000
4	STLS Wet weather characterization	$415,000
5	STLS RWSM	$35,000
6	STLS Trends strategy	$35,000
7	STLS Coordination	$26,000
8	Nutrient modeling	$100,000
9	Nutrient moored sensors	$300,00
10	Nutrient coordination	$20,000
11	Nutrient program development	$50,000
11.5	Conceptual model update	$30,000
12	SQO Pacific Dry Dock	$45,000
13	Dioxin synthesis	$40,000
14	Se study now proposed for 2014	
15	Selenium in plugs and eggs	$20,000
16	Selenium Strategy support	$10,000
17	PCB: PMU conceptual models	$100,000
	Total	$1,045,000
	Avallable funds	$1,028,000

EVALUATING EMERGING CONTAMINANT PATHWAYS: WASTEWATER DISCHARGES

Rebecca Sutton and Meg Sedlak, SFEI, Richmond, CA

ESTIMATED COST: $55,000
OVERSIGHT GROUP: Emerging Contaminants Work Group (ECWG)

PROPOSED DELIVERABLES AND TIMELINE

Deliverable	Due Date
Task 1. Project Management (write and manage sub-contracts, track budgets)	Summer – Dec 2014
Task 2. Collection of wastewater effluent	Fall 2014
Task 3. Laboratory analysis	Fall 2014
Task 4. QA/QC and data management	Dec 2014
Task 5. Draft and final manuscript	Mar 2015

Background

The State Water Resources Control Board's Chemicals of Emerging Concern (CECs) Science Advisory Panel has directed agencies to include sampling wastewater treatment plant (WWTP) effluent and stormwater when screening for emerging contaminants (Anderson et al. 2012). The follow-up state pilot study, now under development, similarly emphasizes examination of these contamination pathways as an important means of providing policymakers with the data they need to make sound, science-based decisions regarding CECs and environmental management (Advisory Panel Meeting 2013). To expand our knowledge of the role of WWTP effluent in contaminating the Bay environment, we propose monitoring high priority and newly identified CECs in this matrix.

This study will expand on already-approved WWTP effluent monitoring for alternative flame retardants and estrogenic contaminants (Denslow et al. 2012; Sutton and Sedlak 2013). Measurements made as part of this study may provide an indication of the relative importance of wastewater as a contamination pathway for specific CECs in San Francisco Bay, especially when compared to local stormwater discharges analyzed as part of ongoing studies (fipronil) or previously characterized in the literature (PFCs; Houtz and Sedlak 2012). In the case of fipronil, comparison of influent to effluent can provide information regarding the effects of treatment processes on contaminants of interest. By encouraging a collaborative monitoring effort among dischargers, it may be possible to avoid implementing new, costly permit requirements.

Applicable RMP Objectives and Management Questions

This study will address the following RMP Objectives and Management Questions:

MQ.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?

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

- A: Do pollutant spatial patterns and long-term trends indicate particular regions of concern?

MQ.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?

Detailed Outline of Study Objectives

1. Describe the distribution and trends of pollutant concentrations in the WWTP effluent pathway leading to the Estuary.

- This study will provide some of the first data to determine the distribution of concentrations of CECs in effluent discharged to the Estuary, and to place these concentrations in context with those observed in other locations.

2. Project future contaminant status and trends using current understanding of ecosystem processes and human activities.

- The relative significance of this exposure pathway in Bay contamination may suggest potential future trends, particularly in combination with time trends observed in biota.

3. Measure pollution exposure and effects on selected parts of the Estuary ecosystem (including humans).

- Policymakers need to know which pathways lead to Bay CEC pollution to evaluate whether management actions are needed.

4. Compare monitoring information to relevant benchmarks, such as TMDL targets, tissue screening levels, water quality objectives, and sediment quality objectives.

- The concentrations detected in this study will be compared to known threshold effect levels, where possible.

Relationship of the Study to the ECWG Priority Question and Current RMP List of Emerging Contaminants

The Emerging Contaminants Workgroup is focused on answering the following question: "What emerging contaminants have the greatest potential to adversely impact beneficial uses in the Bay?"

The State Water Resources Control Board's CEC Science Advisory Panel has directed agencies to include sampling contamination pathways when screening for emerging contaminants (Anderson et al. 2012). For PFOS and fipronil, CECs of moderate concern to San Francisco Bay (Tier III), an evaluation of the effluent pathway of contamination is a logical next step in producing the science that policymakers need to make decisions that maintain Bay health. Comparison of effluent PFOS, PFC, and precursor concentrations from the South Bay with those

of other regions may establish whether this pathway could be a factor in the persistence of South Bay PFOS contamination despite a nationwide production phase-out. Limited data on concentrations of fipronil in influent and effluent suggest this is an appropriate data gap to fill via monitoring.

Finally, some new CECs under consideration for monitoring via special studies might be best examined in effluent first, to determine whether ambient Bay sampling is advisable. These include specific new PPCPs and plastic microbeads.

Approach

PFOS and fipronil (and its degradates), both Tier III (moderate concern) CECs, are strongly recommended as analytical targets for WWTP effluent monitoring as an initial means of assessing the importance of wastewater as a pathway for Bay contamination. As described in the Rationale in Table 1, gaps in knowledge about the importance of the effluent pathway for each of these contaminants could be filled, providing information relevant to potential management actions.

In addition, some new CECs that may merit initial monitoring via a special study might be best examined in effluent to determine whether ambient Bay sampling is advisable. These include specific new PPCPs and plastic microbeads. A specific funding request for these analyses is not included here. Funding limitations necesitate careful consideration as to the utility of each additional target, and for this reason PBDEs are not recommended for effluent monitoring (see Rationale, Table 1).

Samples of WWTP effluent voluntarily provided by up to eight Bay Area dischargers will be characterized. A replicate sample will be collected as well, for a total of up to nine WWTP effluent samples. Effluents obtained via secondary and advanced treatments must be included in the study. An ideal group of WWTPs would include facilities in South, Central, and North Bay, with an emphasis on South Bay dischargers due to the lower levels of dilution and resulting higher concentrations of contaminants in that region. The persistence of high levels of PFOS in South Bay wildlife (Sedlak and Greig 2012) provides another rationale for contrasting South Bay effluents with those from other parts of the Bay. An emphasis on high volume dischargers is also recommended. Finally, inclusion of WWTPs that discharge into wetlands is recommended, as different physical, chemical, and biological processes may occur in wetlands relative to the greater Bay environment.

For PFCs and precursors, an effluent grab sample is considered preferable to a 24-hour composite sample because the equipment used to aggregate samples could expose sample water to potential sources of contamination. In addition, grab samples that pass through teflon pipes at the point of collection will not be suitable for these analyses. Samples will be collected during diurnal peak flow. PFCs/precursors analyses will be conducted by AXYS (~$1,670/sample). Samples will be analyzed for total suspended solids as well.

In contrast, for fipronil and degradates, a composite effluent sample is preferable because any contamination will not interfere with analysis, and a composite sample will assure a

representative measurement should there be diurnal variation in discharge levels. Composite influent samples will also be collected, to further explore findings from a limited number of studies that suggest wastewater treatment does little to reduce concentrations of this pesticide in effluent (Heidler and Halden, 2009; Weston and Lydy, 2014). Fipronil analyses will be conducted by the California Department of Fish and Wildlife or a comparable laboratory (~$400/sample). Samples will be analyzed for total suspended solids as well.

Dischargers are not specifically identified here, and they will have the option to keep their identities confidential in subsequent reporting of the data. Measurements for each discharger will be reported individually using unique identifiers should dischargers request their identities be withheld. Through cooperative relationships with wastewater dischargers, we can obtain and share data about concentrations of CECs in effluent without implementing expensive permit requirements.

Reporting

Results of these proposed study elements will be reported as a RMP Technical Report and/or manuscript in 2015. A conference poster and web-based presentation of said poster (using Prezi software) may also be appropriate deliverables. Comparisons will be made to past screening efforts in the Bay and in the literature from other locations, as well as to relevant toxicological information on these emerging contaminants available at that time. Estimates of the relative contribution of wastewater and stormwater derived contamination will be provided, using stormwater data from ongoing studies or the literature (e.g., Houtz and Sedlak 2012).

Proposed Budget

The budget is presented as separate tasks that can be performed as separate elements or combined.

Task	**Estimated Cost**
Analysis of 2014 WWTP effluent for PFCs and precursors (n=8+1 replicate), data management and reporting	$36,000
Analysis of 2014 WWTP influent and effluent for Fipronil and degradates (n=8+1 replicate for each), data management, and reporting	$19,000
Total	**$55,000**

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TABLE 1:
Effluent CEC Monitoring Priorities

CEC	Tier	Recommend?	Sources	Rationale					
					POTWs	up to 3	up to 2	at least 1	up to 2
					Location	South or Lower South Bay	Central Bay	Suisun or San Pablo Bay	Discharge to wetlands
					Likely Treatment	advanced secondary (filtration)	secondary	secondary	either
Alternative flame retardants	I possible concern	APPROVED	Flame retardants in consumer goods	Budget for 3 samples; dischargers have agreed to provide samples if their identities are kept confidential in report		X	X		
NP/NPEs	III moderate concern	APPROVED	Toilet paper, detergents (phasing out), many others	Budget for 1 sample		X			
BPA, Galaxolide, Estrone	I possible concern BPA; II low concern galaxolide	APPROVED	BPA: plastics, canned food linings; Galaxolide: fragrance in personal care, cleaning products; Estrone: hormone	Budget for 1 sample		X			
PFOS, PFCs and precursors	III moderate concern PFOS; I possible concern	Recommend	Stain repellant, fire-fighting foam, metal-finishing	South Bay seals still have high levels; POTW monitoring may indicate sources specific to the South Bay		X	X	X	X
Fipronil	III moderate concern	Recommend	Professional application around buildings; consumer flea spot-on treatments and baits	Limited data available; injection around buildings may penetrate sewers; Kelly Moran recommends testing; results may be useful to EPA reregistration decision		X	X	X	X
PBDEs	III moderate concern	Do not recommend	Flame retardants in consumer goods (phased out)	Not Recommended: Previous studies on WWTP effluent exist; monitoring data indicate levels in decline					
New PPCPs	I possible concern	In development	Pharmaceuticals, personal care products, plastics	New targets under consideration		X	X	X	X
Microbeads	I possible concern	In development	Personal care products	New proposal; does filtration from advanced treatment remove these from discharge?		X	X	X	X

IDENTIFYING CURRENT USE PESTICIDES (CUP) TO INCLUDE IN FUTURE RMP MONITORING

Ellen Willis-Norton and Rebecca Sutton, SFEI, Richmond, CA, and Kelly Moran, TDC Environmental, San Mateo, CA

ESTIMATED COST: $55,000
OVERSIGHT GROUP: Emerging Contaminants Work Group (ECWG)

PROPOSED DELIVERABLES AND TIMELINE

Deliverable	Due Date
Task 1. Project Management (write and manage sub-contracts, track budgets)	Fall 2014 – Dec 2015
Task 2. Desktop analysis of CUP application timing	Fall 2014
Task 3. Collection of first round of CUP water and sediment samples	Spring 2015
Task 2. Collection of second round of CUP water and sediment samples	Aug/Sept 2015
Task 3. Laboratory analysis	Spring/ Fall 2015
Task 4. QA/QC and data management	Dec 2015
Task 5. Presentation and report to ECWG	Spring 2016

Background

The RMP monitors legacy pesticides (e.g., DDT, chlordanes, dieldrin) as part of the Status and Trends (S&T) program. Use of these legacy pesticides ended between 40 and 50 years ago and the RMP has observed a slow decline in concentrations since 1993 (SFEI 2014). As many S&T contaminant concentrations begin to decline or stabilize, the RMP has begun focusing efforts on Contaminants of Emerging Concern (CECs), including current use pesticides (CUPs).

The RMP's CEC Strategy includes ranking the relative risk of CECs to the Bay based on a tiered risk framework. All CUPs are ranked in Tier I (Possible Concern), excluding Fipronil and Pyrethroids (Moderate Concern and Low Concern respectively). CUPs are included in Tier I because there is uncertainty in their predicted concentrations, the level of effect on Bay wildlife, and their environmental fate. The CEC Strategy suggests screening level monitoring efforts for Tier I contaminants to help determine their concentration in ambient Bay water and sediment, effluent, runoff, and biota (Sutton et al., 2013).

There are over 1,000 CUPs in existence; therefore, prioritizing which CUPs to monitor in the Bay is essential (SFEI 2013). The RMP developed a comprehensive monitoring priority list for agricultural CUPs. The list was created using spatially-explicit use data provided by the Department of Pesticide Regulation's California Pesticide Information Portal. Only agricultural pesticides, rather than both urban and agricultural, were included in the list because agricultural use data is reported to the township level. The RMP evaluated the top 50 highest use pesticides within the Region 2 Water Quality Control Board boundary and determined their risk ratio (total use/lowest aquatic life benchmark).

The 20 agricultural pesticides with the highest risk ratio were: Naled, Oxyfluorfen, Flumioxazin, Pyraclostrobin, Mancozeb, 1,3-dichloropropene, Dimethoate, Imidacloprid, Paraquat Dichloride,

Metam-Sodium, Thiophanate-Methyl, Cyprodinil, Trifloxystrobin, Methomyl, Pendimethalin, 2,4-Dichlorophenoxyacetic acid, Diquat Dibromide, Oryzalin, PCNB, and Triflumizole. The use data for all 20 pesticides was mapped to determine where pesticide use was concentrated. The majority of the pesticides were applied in Napa County, while some pesticide use was concentrated on the southern edge of Santa Clara County (e.g. Naled) or on the coast of San Mateo County (e.g. Metam-Sodium). Relatively high agricultural pesticide use indicates that agricultural pesticide concentrations are likely highest in the Napa River and subsequently San Pablo Bay.

Applicable RMP Objectives and Management Questions

This study will address the following RMP Objectives and Management Questions:

MQ.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?

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

- A: Do pollutant spatial patterns and long-term trends indicate particular regions of concern?

MQ.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?

Approach

CUPs are Tier I chemicals; therefore, the CEC Strategy recommends a screening level monitoring study. We propose monitoring the following eight CUPs at three locations within the Napa River in this special study:

1. Oxyfluorfen
2. Pyraclostrobin
3. Mancozeb
4. 1,3-dichloropropene
5. Imidacloprid
6. Paraquat Dichloride
7. Pendimethalin
8. Diquat Dibromide

The above pesticides were chosen because they were either within the top 10 list with environmental fates that suggest they could enter the Napa River, or on another monitoring group's prioritization list, or the analysis of the pesticide was free. The three monitoring group list's that were compared to the RMP's were the Central Valley Water Board's high relative risk

list (Lu and Davis 2009), the DPR's monitoring priority list (Budd et al. 2013; Luo et al. 2013), and the Urban Pesticides Pollution Prevention Project watch list.
The monitoring plan is to time sampling in the Napa River with pesticide application. The first part of the study will focus on determining the timing of the various pesticide applications. Typically, pre-emergence pesticides are applied in the spring while post-emergence pesticides are applied in the late summer. Therefore, there will be two day-long sampling cruises in 2015 to sample sediment and water at the three locations after both sets of pesticide applications. RMP staff will work with Kelly Moran to determine the exact dates of the pesticide's application.

The sediment and water samples will be sent to North Coast Laboratories Ltd., a laboratory with expertise in pesticide analyses. The RMP will also likely send samples to the East Bay Municipality District's laboratory to determine if their results are comparable to that of North Coast Laboratories. If so, the RMP will use EBMUD for future CUP monitoring studies. Lastly, Dr. Lee Ferguson of Duke University has offered to run several of the samples pro bono using a broadscan method that may identify additional pesticides of interest.

This special study is a screening level effort to determine if agricultural CUPs that are applied in Napa and Sonoma County have the potential to enter the Bay. The concentrations of the eight CUPs will be compared concentrations from other monitoring studies and to the pesticide's lowest aquatic life benchmark.

Reporting

Results of the proposed screening level study will be reported to the Emerging Contaminants Workgroup during its Spring 2016 meeting. Comparisons will be made to screening efforts in other locations, as well as to the CUP's lowest aquatic life benchmarks.

Proposed Budget

Task	**Estimated Cost**
Desktop analysis, project management, reporting	$15,400
Sampling Cruise collection of CUPs in water and sediment in the Napa River (Spring and Summer 2015)	$7,000
Laboratory analysis of 2014 Napa River sediment and water for CUPs	$23,000
QA/QC, data management	$9,600
Total	**$55,000**

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MONITORING MICROPLASTICS IN SAN FRANCISCO BAY

Ellen Willis-Norton and Rebecca Sutton, SFEI, Richmond, CA

ESTIMATED COST: $8,800
OVERSIGHT GROUP: Emerging Contaminants Work Group (ECWG)

PROPOSED DELIVERABLES AND TIMELINE

Deliverable	Due Date
Task 1. Project Management (write and manage sub-contracts, track budgets)	Summer – Dec 2014
Task 2. Collection of ambient sediment samples	Summer 2014
Task 3. Collection of ambient water samples	Fall 2014
Task 2. Collection of wastewater effluent	Fall 2014
Task 3. Laboratory analysis	Fall/Winter 2014
Task 4. Data management	Spring 2014
Task 5. Presentation to ECWG	Apr 2015

Background

General Background:
Microplastic is a term used to describe fragments of plastic that are less than 5mm (Wright et al., 2012). Microplastics can be pellets that are used as precursors for industrial products, microbeads used in consumer products (e.g. exfoliants), or fragments/fibers of plastics that are the breakdown products of larger plastic materials. Microplastics can enter the aquatic environment through wind, stormwater runoff, or illegal dumping of plastic materials (Eriksen et al. 2013). Additionally, both microbeads from cosmetic products and plastic fibers (e.g., polyester and acrylic) from clothing can be washed down the drain and enter wastewater treatment plants (European Commission 2012). Microplastics are not captured by wastewater treatment plants because they are buoyant and do not flocculate; therefore, they are released in wastewater (Hogue, 2013). It is important to note that both California and New York have proposed bans on microplastics found in cosmetics (Badore 2014). Additionally, Johnson & Johnson, L'Oréal, Colgate-Palmolive, and Procter & Gamble have pledged to phase out the use of microbeads in their skin cleansers (Hogue 2013). Therefore, the concentrations entering wastewater may decrease in the future.

Microplastics are found in surface waters, the water column, and sediment because of the varying density of plastic particles. They can also be found in the gut and circulatory system of aquatic organisms that ingest the particles. Studies have found that microplastics are also able to adsorb to organisms, blocking their feeding appendages (Wright et al., 2012). Ingestion of microplastics can block the digestive tract, reduce growth rates, block enzyme production, lower steroid hormone levels, affect reproduction, and cause the adsorption of toxins (Wright et al., 2012). The potential for ingesting toxins occurs because microplastics readily accumulate hydrophobic organic compounds, due to their high surface area to volume ratio (Teuten et al., 2007). In fact, the sorption of persistent organic pollutants (POPs) to microplastics exceeds sorption to sediments by two orders of magnitude (Mato et al., 2001); in one study, the concentration of POPs on microplastics was six orders of magnitude higher than the

concentration in the surrounding water column (Teuten et al. 2007). Therefore, the ingestion of microplastics by organisms can increase the exposure of aquatic life to toxic pollutants.

Microplastic Monitoring Studies

Plastic pollution has increased over the past several decades and is the dominant type of pollution in aquatic environments (Eriksen et al., 2013). Both industrial and densely populated coastal areas have been identified as microplastic hotspots (Wright et al., 2012). Most studies on plastic pollution in the United States have focused on macro-plastics (Ryan et al., 2010). Studies regarding microplastic pollution have been focused in the North Sea. However, there has recently been a handful of microplastic monitoring efforts in the United States, including a study in Santa Monica Bay, the Los Angeles River, and an on-going study in the Great Lakes.

The Santa Monica Bay study was completed in 2001 and was a partnership between the Algalita Marine Research Foundation and the Southern California Coastal Water Research Project. The study was noteworthy because it was the first microplastic monitoring effort that not only measured the abundance in the surface layer, but also at mid-depth and at the sediment-water interface (Lattin et al., 2004). The study monitored microplastics at varying depths because only 46% of microplastics are positively buoyant. The study observed microplastics at all depths and found that the abundance increased considerably after a storm event. Another microplastic study is just beginning in the Los Angeles area; Dr. Marcus Eriksen is monitoring microplastics in the Los Angeles River. The study will help determine if microplastics are entering Los Angeles' coastal waters through the urban watershed.

Microplastic pollution is also currently being measured in the surface waters of the Laurentian Great Lakes. The study found that microplastic pollution was greatest in Lake Erie, most likely because it is the most populated region (Eriksen et al., 2013). Unlike the Santa Monica Bay study, the microplastics were analyzed using scanning electron microscopy. Therefore, both abundance and the chemical composition of the particles were analyzed. The study is on-going and the researchers, including the project lead Sherri Mason (SUNY Fredonia), are currently considering adding effluent sampling to the monitoring effort.

Previous San Francisco Bay Monitoring

In 2011, microplastics were sampled in San Francisco Bay surface waters at six sites. The RMP partnered with Ian Wren at San Francisco Baykeeper and Joel Baker and Julie Masura at the University of Washington, Tacoma to complete the study. The study determined the mass of microplastic at sites in Central Bay that were suspected to be most influence by trash. The six sites were Oyster Bay, San Leandro Bay, Oakland Estuary, Berkeley Marina, Richmond Inner Harbor, and the San Francisco Waterfront. The concentration of microplastics ranged from 0.064 to 7.215 ug/L, similar to the concentration range observed in Puget Sound (LaRocque et al., 2011). However, the study only measured the mass of the microplastics, rather than the abundance and composition. Additionally, effluent has not yet been monitored in San Francisco Bay. Monitoring effluent would help identify whether personal care products were a significant source of microplastic pollution in the Bay.

Applicable RMP Objectives and Management Questions

This study will address the following RMP Objectives and Management Questions:

MQ.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?

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

- A: Do pollutant spatial patterns and long-term trends indicate particular regions of concern?

MQ.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?

Approach

San Francisco Bay is a densely populated area with a high potential for microplastic pollution. Given the risk of microplastic ingestion by aquatic life, monitoring the abundance and composition of microplastics in WWTP effluent and the ambient Bay would be worthwhile.

Two size fractions of microplastics will be sampled, > 0.355-mm and 0.125-0.355-mm (the size fraction that is characteristic of personal care product microbeads), in WWTP effluent and Bay sediment and water. Ambient Bay sediment sampling will occur during the 2014 RMP S&T sediment cruise (August 2014). Ten sediment samples will be collected throughout the Bay using a modified van Veen grab. The 10 stations will be a subset of the 27 stations sampled during the S&T sediment cruise and will emphasize Central and South Bay, where microplastic contamination is expected to be greater. Ambient Bay water sampling will occur soon after sediment sampling in Fall 2014. The samples will be collected from the same sites using planktonic nets. The samples will be collected separately from the sediment samples because it is logistically difficult to complete both types of field sample collections during one cruise.

WWTP effluent samples will be voluntarily provided by six Bay Area dischargers in Fall 2014. SFEI field staff will visit the sites and set-up a pump with a 0.355-mm sieve and pump water from the plant's effluent trough through the sieve for 24 hours. Dischargers are not specifically identified here, and they will have the option to keep their identities confidential in subsequent reporting of the data.

The effluent, water, and sediment samples will be sent to Dr. Sherri Mason at SUNY Fredonia for sample processing, visual sorting, and abundance measurements.

Reporting

Results of these proposed study elements will be reported to the Emerging Contaminants Workgroup during its Spring 2015 meeting. Comparisons will be made to monitoring efforts in other locations.

Proposed Budget

Task	**Estimated Cost**
Field collection of WWTP effluent and ambient Bay water for microplastics, vessel rental, and shipping	$5,400
Analysis of 2014 WWTP effluent (n=6), ambient Bay sediment (n=10), and ambient Bay water (n=10) for microplastics	$2,600
Project management and power point presentation to ECWG	$800
Total	**$8,800**

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SMALL TRIBUTARIES LOADINGS

Lester McKee, Jennifer Hunt, Alicia Gilbreath, and Jing Wu, SFEI, Richmond, CA

ESTIMATED COST: $511,000
OVERSIGHT GROUP: Sources Pathways and Loading Work Group (SPLWG)

PROPOSED DELIVERABLES AND TIMELINE

Task	Deliverable	Due date															
		2014				2015											
		S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D
1	Small tributaries wet weather characterization [MQ 1]																
1a	Wet season monitoring			!		!		!	!								
1b	Quality Assurance & Data Management																
1c	Interpretation & reporting													!		!	
2	Regional watershed spreadsheet model (RWSM) y5 [MQ 2]																
2a	Finalize work plan based on latest info. and priorities									!!							
2b	Compile latest data (GIS & stormwater data (Task 1)										!	!	!				
2c	Recalibrate model, estimate loads, & update model report													!	!	!	
3	Watershed loadings trends strategy support [MQ 3]																
3a	Devise & prioritize study questions (STLS oversight)					!	!										
3b	Identify analysis/interpretative methods (SPLWG oversight)							!!									
3c	Complete analysis & present prelim. findings to SPLWG								!	!!							
3d	Complete white paper (STLS/SPLWG review)										!		!				
4	Small tributaries loading strategy coordination support					!		!		!		!		!		!	

[MQ] = Municipal regional stormwater permit (MRP) and small tributary is loading strategy management questions
! = STLS check in for review and coarse corrections
!! = STLS/SPLWG oversight and review

Background

The San Francisco Bay Hg and PCB TMDLs call for a reduction in loads by 50 and 90% respectively. In response, the Municipal Regional Permit for Stormwater (MRP) Provision C.8.e. calls for a range of actions including gaining a better understanding of which Bay tributaries contribute most loading to sensitive areas of biological interest on the Bay margin, better quantification of loads of sediments and trace contaminants on a watershed basis and regionally, a better understanding of how and where trends might best be measured, and an improved understanding of which management measures may be most effective in reducing impairment. These same needs are reflected in the small tributary loading strategy (STLS) priority questions listed below. In addition, the Water Board, through provision C.11. and C.12. of the permit, called for PCB and mercury source and source area identification to identify a set of sites for pilot testing the efficacy of various best management practices for addressing loads and impairments.

Beginning with planning efforts in1999in 1999 -2002 (first report of the Sources, Pathways and Loadings Workgroup and the "Urban run-off literature review") and field studies beginning water year (WY) 2001 at Mallard island on the Sacramento River (which was then perceived as the largest single PCB and Hg loading pathway to the Bay), and continuing the following wet season with the instigation of a loading study on the Guadalupe River in San Jose (also perceived as a large loading pathway for both Hg and PCBs), the RMP made considerable progress on investigating the magnitude of loading to San Francisco Bay from WY 2001-2006. This effort continued with another fixed station loading study at a small 100% urban and industrial tributary called Zone 4 Line A in Hayward.

These studies provided basic information to inform TMDL implementation as well as providing a valuable dataset for many other purposes, including reevaluating study design in relation to the issuance

of the MRP in October 2009. As a result of this permit and the need to better understand which tributaries were contributing to greatest load per unit area (MQ 1), the RMP funded a reconnaissance study, the data from which (along with other information) supported the instigation of four additional fixed station loading studies in WY 2012 and two more, for a total of six, in WYs 2013 and 2014 that were deemed "no regret watersheds" and suitable for baseline information on which to measure future trends (MQ 3).

In addition the RMP funded the development of the Regional Watershed Spreadsheet Model (RWSM) as a tool for estimating regional and sub-regional loads (MQ 2) and an additional study component recommended by the STLS team to improve our understanding of source areas (GIS layer development) and event mean concentrations (EMC); the loading coefficients associated with each of the source areas (MQ 1).

The data obtained from the reconnaissance study (MQ 1) and the loading study (MQ 3) as well as efforts to better quantify the characteristics of our PCB and source areas (MQ 1)), together constituted an entire program of investigation. Of course, this was not occurring in a vacuum in relation to other strategies, in particular the Bay modeling strategy and the PCB and Hg strategies (and associated small fish studies) as illustrated in Figure 1. Indeed, the ongoing success of the STLS program component as a whole cannot occur without sustained support from the RMP and a programmatic vision with appropriate linkages across other strategies. As with all programs, the individual tasks must and do connect together as illustrated by the arrows (Figure 1). For example, characterization data obtained from field studies primarily aimed at answering MQ 1 are also needed to provide calibration data for the RWSM modelling effort being developed to answer MQ 2. The fixed station loading studies aimed at providing baseline data against which to measure future trends in relation to management actions (MQ 3), also provide data for helping to verify the RWSM. In addition, BASMAA utilized these data in Part C of their Integrated Monitoring Report to independently estimate regional loads and loads associated with specific land uses and provide the basis for predicting the effects of management actions (MQ 4). The development of GIS data and the back calculation of EMC data in relation to source identification (MQ 1) provide the necessary input data for the RWSM (MQ 2). Going forward, the small fish studies, the Bay margins conceptual model report, and the proposed conceptual model development for priority Bay margin units will provide an even greater linkage between sensitive biological areas on the Bay margin and upstream sources and potential management actions.

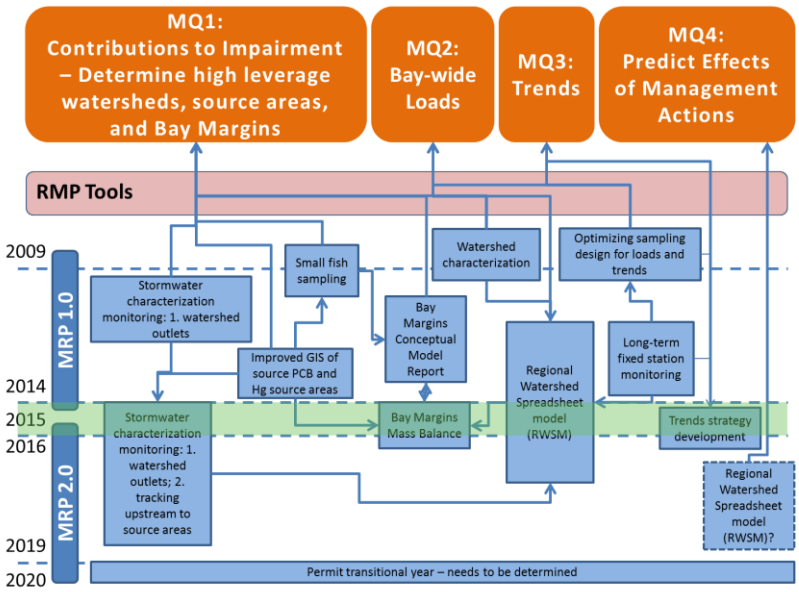


Figure 1. Key linkages between RMP funded studies within the overall small tributaries loading programmatic strategy. Highlighted in green are the proposed elements for 2015 put in context with previous funded elements and possible future elements.

Much has been learned over the past 15 years and many of the efforts during the first MRP term from 2009 to 2014 were very well supported by the massive amount of data and information collected by the RMP through the oversight of the Sources Pathways and Loadings Workgroup. The focus, in terms of RMP funding, has largely been devoted to better understanding loadings (MQ 2) (Figure 2).

However, during the next permit term (MRP 2.0), the Water Board and BASMAA are asking for an increased focus on identifying watersheds and areas within watersheds that are producing disproportional loads in relation to impairment in Bay margin areas (MQ 1) while maintaining some effort on the loadings question (MQ 2), and developing and implementing a plan to determine trends (demonstrating that management efforts are effective at reducing impairment).

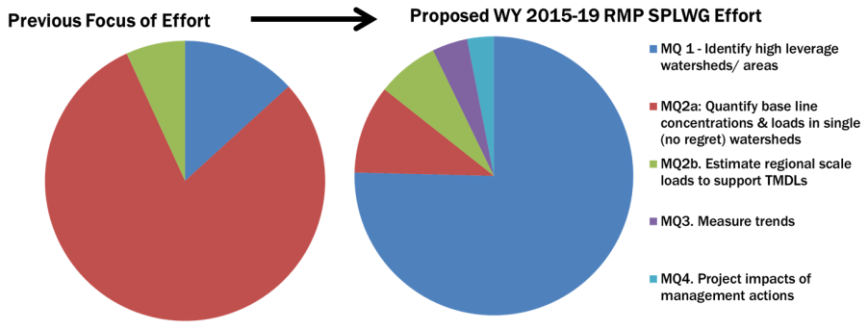


Figure 2. Illustration of the proposed programmatic change in focus between RMP STLS funded efforts during MRP 1.0 (2009-14) and proposed efforts during MRP 2.0 (2015-19). Note, direct effort by BASMAA through grants and their city/county resources are not included (but substantial).

At this time, the Water Board and BASMAA (through discussions within and outside the STLS) are not recommending any increased focus through the RMP on true source area identification (MQ 1) or predicting the potential effectiveness of management actions (MQ 4). Substantial efforts have been and are ongoing in relation to these management questions outside of RMP funding by BASMAA through a $5 million EPA Water Quality Improvement Fund grant called Clean Watersheds for a Clean Bay (CW4CB). Pending the results of these studies, it is possible that, in the next 6 to 18 months, RMP support could be requested to build upon the results from these efforts. Results from the proposed elements within the PCBmercury strategy will also likely mature and give further support for increased understanding of true sources and the potential of source control and overall program of load reduction towards meeting TMDL goals.

Applicable RMP, STLS / MRP Management Questions (MQs)

Level I RMP, Q3:	What are the sources, pathways, loadings, and processes leading to contaminant-related impacts in the Estuary?
Level II RMP, Q3C:	What is the effect of management actions on loads from the most important sources, pathways, and processes?
Level III SPL Q2:	What is the watershed-specific and regional total water flow, load of sediment, and load of contaminants entering the Bay from the urbanized small tributaries and non-urban areas draining to the Bay from the nine-county Bay Area and are there trends through time?
Level IV STLS Q1:	Impairment: Which are the "high-leverage" small tributaries that contribute or potentially contribute most to Bay impairment by pollutants of concern?
Level IV STLS Q2:	Loads: What are the loads or concentrations of pollutants of concern from small tributaries to the Bay?
Level IV STLS Q3:	Trends: How are loads or concentrations of pollutants of concern from small tributaries changing on a decadal scale?

Level IV STLS Q4: Support management actions: 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?

Approach

Task 1. Small tributaries stormwater characterization field study [MQ 1]

- Monitoring Design: 1 composite/site, unless unexpected low concentration and methods development for one remote sampler type at 12 locations. Methods inter-comparison study using 12 fractionated water samples versus remote sampler sediment data.
- Site Selection: A balance between two overarching rationale:
    - Nested sampling design to track sources upstream in known polluted areas to help better define source areas and management options.
    - Finding new polluted watersheds or sub-watershed areas (watershed locations near the Bay margin or at least further downstream than the source tracking approach).
    - Possible use of ELISA this summer to support site selection (c.f. PCB strategy and SPL recommendations for increased source I.D. effort (using remaining 2014 POC funding).
    - Other section rationale:
        - 1 site/yr large watershed [MQ 2]
        - Re-sampling potential false negatives [MQ 1 & 2]
        - Contingency for resampling Guadalupe River for trends [MQ 3]
        - Filling gaps along environmental gradients in relation to source areas (most specifically to support RWSM development [MQ 2])
- Remaining questions before design and budget can be finalized:
    - Final decision on the choice of remote sampler (need further expert input)
    - Final decision on analyte list and D.L.s (PCBs, Hg, org. carbon, GS, TMs at select sites)
    - Data management costs?
    - Final total number of field sites (largely the result of all other decisions)

Task 2. Regional watershed spreadsheet model (RWSM) [MQ 2]

- Sub-regional scale loads needed to support TMDL updates and linked to PCB strategy a margins mass balance (2015 proposal)
- Pending the outcomes of the 2014 work plan, STLS to agree upon and recommend the workplan for 2015. 2014 work plan:
    - Use GIS databases incorporating the latest BASMAA improvements and fix anomalies (e.g. wrongly assigned open space or pervious areas land uses that don't make sense)
    - Coalesce small near homogeneous "watersheds" mostly on the Bay margin into nearby areas that correspond more directly to real-world land use zones
    - Use the uncalibrated parameters to explore ranking watersheds, sub-watersheds, or patches to support management prioritization
    - Rerun the model calibration based on the sediment base model, the GIS improvements, and an added data quality weighting factor, and regenerate watershed and regional load and sensitivity analysis
- Increase funding to ensure the model is completed? From $35 - $50k?
- Depending on 2014 outcomes, RMP 2015 funds might be used to:
    - Improve the basis of the model
        - Shift the model to a water-based starting point or
        - Complete further structural improvements to the sediment-based model including adding a hydrology parameter
    - Incorporate additional calibration watersheds (Task 1 [MQ 1] above) and BASMAA studies.

Task 3. Watershed loadings trends strategy support [MQ 3]
The SPL workgroup proposed an effort to define where and how trends may be most effectively measured in relation to management effort in the context of ensuring data collection methods deployed now [MQ 1] are able to support this future need. The SPL proposed development of a framework to define the long term trajectory of the STLS program and ensure that all MQs are answered in the timeframe needed.

- Develop a trends strategy White Paper (could include further power analysis of existing data).
  - Where (what scale) could trends be measured to demonstrate the effectiveness of management efforts in relation to environmental benefits?
  - What are the appropriate media and metrics upon which to measure trends and what constitutes a suitable baseline against which to measure future changes?
  - What data have been collected to-date which may serve as baseline data – is there a cost-effective and on to efforts to answer MQ 1? Is there a need for a fundamental rethink since the previous power analysis to support trends was based on fixed station monitoring data and large datasets?
  - What will be the reasonable temporal checkpoint for defining trends?
  - Develop a field work plan and costs, and set aside RMP contingency funds for sampling Guadalupe River under a large reservoir release event (which might end up being funded through task 1 or perhaps a request to the RMP on an as opportunity arises basis.
  - Develop a list of other potential sites for sampling trends under specific circumstances.

Task 4. Small tributaries loading strategy (STLS) coordination support.

- Local STLS meetings (agenda and meeting materials development)
- Phone conferences for product updates and review (agenda and meeting materials development)

Proposed Budget (will be revised pending planning efforts during June-August)

Task	Sub-Task	Deliverable	Estimated Budget
1. Small tributaries wet weather characterization [MQ 1]	1a	Stormwater monitoring	$415k
	1b	Quality Assurance & Data Management	
	1c	Interpretation & reporting	
2. Regional watershed spreadsheet model (RWSM) [MQ 2]	2a	Finalize work plan based on latest info. & priorities	$35k
	2b	Compile latest data (GIS & storm data (Task 1)	
	2c	Recalibrate model, estimate loads, & update report	
3. Watershed loadings trends strategy support [MQ 3]	3a	Devise & prioritize study questions	$35k
	3b	Identify analysis/interpretative methods	
	3c	Complete analysis & present prelim. findings	
	3d	Complete white paper	
4. Small tributaries loading strategy (STLS) coordination support			$26k

Note, the 6/9/14 STLS meeting reached agreement on proposed tasks but not absolute budget proportions. With the exception of Task 4, the tasks will be scoped according to budget available and better definition of priorities.

To:	RMP Technical Review Committee
From:	David Senn and Emily Novick
Re:	CY2015 Nutrient Proposals

June 22, 2014

Dear TRC:
Attached please find a set of proposals for San Francisco Bay Nutrient Science Program Projects. The proposed projects were identified with input from technical advisors and are aligned with recommendations laid out in the draft Conceptual Model Report, Monitoring Program Development Plan, and Modeling Development Plan. SFEI staff are working with collaborators, Water Board staff, and stakeholders to develop a Nutrient Science Plan. The Science Plan will be developed over the subsequent year and will be broadly vetted among technical advisors and stakeholders, and will eventually receive external review by an expert panel.

Until the draft Science Plan has been vetted, our plan is to continue moving nutrient work forward, recommending and carrying out work that can be considered "no regrets", as we have done over the past 2 years. By no regrets, we mean that the proposed work is considered to be broadly essential across all projects, or as both appropriately timed and falling along the critical path toward informing important management decisions.

Nutrient Science Program Funding: Currently, RMP and funding through the Nutrient Watershed Permit are the primary sources of revenue for San Francisco Bay Nutrient Strategy related work in the Bay. The RMP Multi-Year Plan from 2013 proposed $500,000 in funding for nutrient-related work in 2015, distributed among the focus areas presented in the table below. Total proposed funding for those focus areas is shown in the column second from the right. The accompanying packet contains a slate of proposed projects for the entire Nutrient Science Program Budget in FY2015, with the value identified in the second column from the left being the RMP support requested toward that activity. Any remaining funding will be requested through the Nutrient Steering Committee or other potential funders.

	RMP Allocation in Multi-Year Plan for CY2015 ($1000s)	Overall Proposed Nutrient Science Program Funding FY 2015 ($1000s)	Related Project among FY2015 projects
Modeling (forecasting):	$100	$500	P.1
Moored sensors:	$300	$340	P.3
Monitoring Program Development	$50	$270	P.4
Conceptual model (interpreted here as updates to conceptual models through data synthesis and interpretation)	$30		P.4 (i.e., data synthesis)
Science Coordination/Program Management	$20	$200	P.15
Total	$500	$1310	

				Program Area				Adverse Impact Pathway				
#	Project	Priority for FY2015	Estimated Cost ($1000s) FY2015	Monitoring	Special Study	Modeling	Assessment Framework	High Biomass LowDO Deep Subtidal	LowDO Shallow/Margin	HABs	Altered phytoplankton community	Low production
1	Modeling	High	500			X		X	X	X	X	X
2	Toxin measurements and phytoplankton composition	High	200	X	X		X			X	X	
3	Moored sensor program development/expansion	High	340	X				X	X	X		
4	Monitoring Program development, assessment framework: Analysis of historic data, program design	High	270	X				X	X	X	X	
5	Stratification scenarios for DO and HABs	High	110			X	X	X		X	X	
6	Using monitoring data in conjunction with existing hydrodynamic modeling output to inform monitoring program design	Medium	120	X		X		X		X	X	
7	DO objectives (lit review, data analysis)	High	100				X	X	X			
8	Dissolved Oxygen in shallow habitats	High	300		X				X			
9	Additional Monitoring at current main channel stations in SFB, USGS cruises: phytoplankton taxonomy, nutrients	High	100	X				X		X	X	
10	Suisun Phytoplankton Growth: Continuation of pure culture experiments	High	60		X							X
11	Contribution to shared Research Vessel Purchase, in collaboration with USGS and other potential partners	High	400	X				X		X	X	X
12	Targeted mechanistic studies of HABs, phytoplankton composition, related to nutrient concentrations, forms	Medium	200		X					X	X	
13	Fish/benthos studies in margin habitats to inform site specific DO objectives	Medium	200		X		X	X	X			
14	Sediment flux studies: Benthic oxygen demand, nutrient fluxes/transformations	Medium	250		X			X	X			
15	Program management/science coordination	High	200									
16	External Review	Medium/ High	50									
	Total		3,400									

P.1 Water Quality and Hydrodynamic Modeling	**Priority = HIGH**
FY2015 Cost = 500,000; Year 1 funding of a multi-year project. (Note: $350,000 already secured through RMP)	
Collaborators: SFEI, USGS-Menlo, UC Berkeley, Stanford, UC Davis, key consultants	

This project will begin the development of a water quality (WQ) model for San Francisco Bay to inform nutrient management decisions, and in parallel contribute to the development of the underlying hydrodynamic model through collaboration with USGS-led project CASCaDE II.[1] WQ modeling is the highest priority undertaking for FY2015 for two reasons:

- It will play fundamentally-important roles along the critical path toward informing most management decisions related to assessing health/impairment relative to primary indicators and identifying management actions that would mitigate or prevent impairment.
- Considerable work is needed to develop reliable WQ models

While there are numerous hydrodynamic models for the Bay, there are no WQ models coupled to hydrodynamic models that can be applied toward informing nutrient management decisions. Therefore, the primary Year 1 focus of this multi-year project will be on building regional capacity in WQ modeling. Hydrodynamic model development will move forward through collaboration with the CASCaDE II project, allowing the Nutrient Science Program to leverage ~$2mill in project funding from the Delta Science Program and USGS internal monies. WQ model development and application will be a multi-year effort, and that effort is anticipated to be among the more resource-intensive activities over the next several years. Fortunately, $350,000 in funding has already been allocated by the RMP toward developing this model (combined funds set aside from CY2012-2014) and can be used toward the total estimated cost in FY2015.

The phrase “water quality modeling”, as used here, covers a wide range of parameters and processes, and would be more accurately called biogeochemical (or reactive-transport) modeling plus ecosystem or ecological modeling. Numerous parameters/state variables and processes will be included within the WQ model:

- Predicted nutrient concentrations, and the loads, transformations between nutrient forms, uptake, and losses that create the predicted concentrations
- Phytoplankton biomass (i.e., total biomass) and production rate, loss rate (settling, death, grazing)
- Benthic grazer abundance and grazing rates (e.g., filter feeding clams) and pelagic grazer abundance and grazing rates
- Dissolved oxygen concentrations and the various process add or remove oxygen (+ primary production, air:water exchange; – phytoplankton and planktonic microbial respiration, sediment oxygen demand, nitrification, etc.)

[1] http://cascade.wr.usgs.gov/

- Nutrient and DO fluxes between the water column sediments, and similar reactions as above within the sediments that drive these fluxes
- Phytoplankton community composition: abundance of several classes of phytoplankton, class-specific growth requirements and growth rates
- Light availability, based either on suspended sediment output from the hydrodynamic model, or specified through a seasonally/spatially varying input file

WQ modeling will proceed in a phased approach (see schematic on p.2), as recommended by a team of modeling experts. After thorough examination of modeland potential platforms, the team recommended that we proceed with Deltares suite of models.[2] The Year 1 focus will be on addressing several key questions related to ecosystem response in simplified-spatial-domain subembayment models (important questions in South/Lower South Bay and Suisun Bay), allowing us to focus more energy on understanding the complex water quality processes, biological response, and physical drivers. In addition to building a solid quantitative-conceptual foundation over that year, work will proceed on gathering/building the key input files and setting up higher spatial resolution models at subembayment and whole-bay scales that will be the focus of work in Year 2 and beyond. While the primary hands-on modeler will be a new SFEI staff person, we plan to continue convening a technical advisors (including experts from Deltares, who will be major collaborators), some providing high level technical guidance and some providing hands-on support.

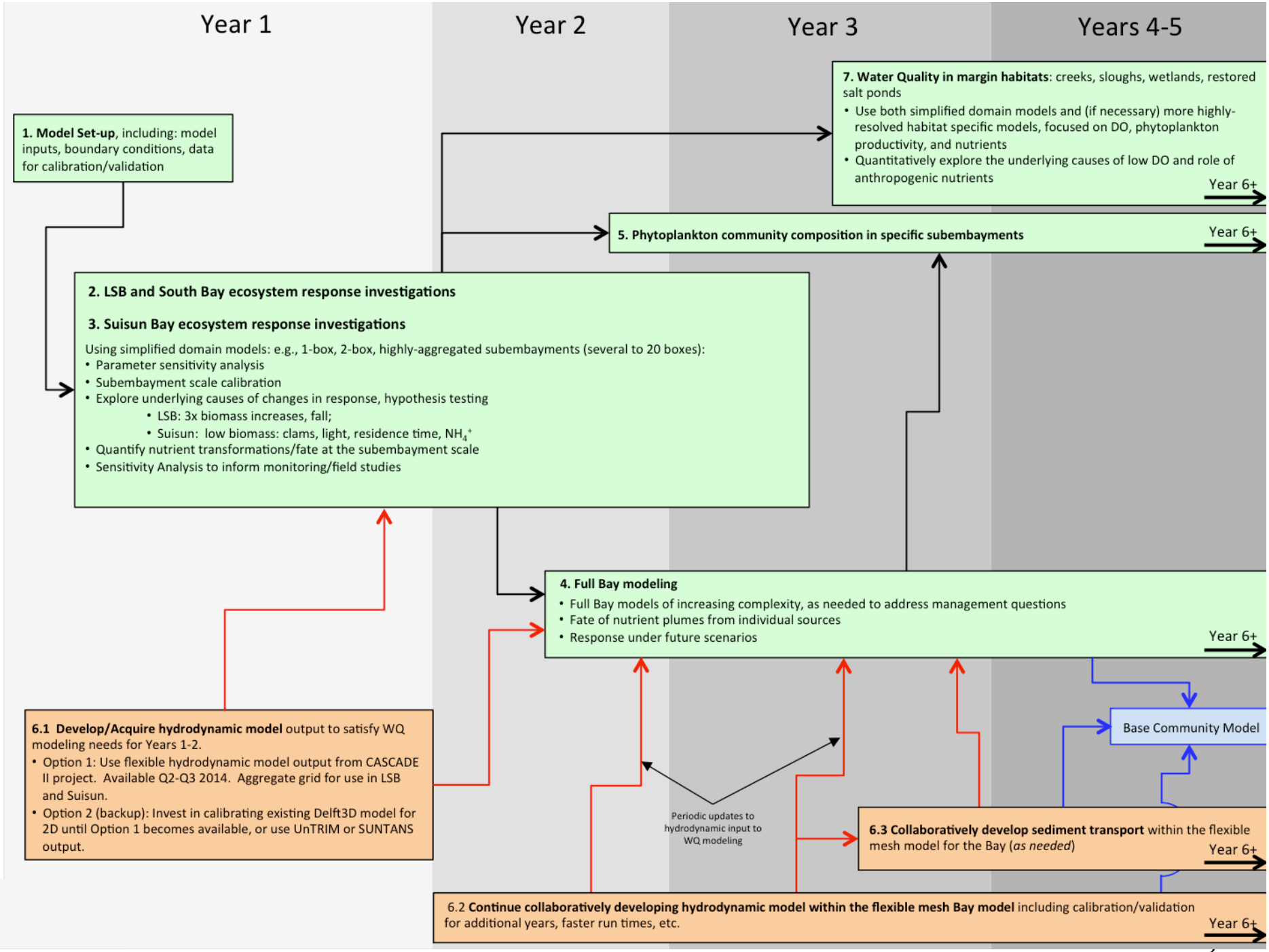
Year 1 Deliverables

A technical report document will be produced in June 2015 to describe Year 1 progress, and to identify recommended next steps next steps.

Budget

The majority of the salary will be directed toward a full time WQ modeler and collaborating staff (~$300k). The remainder will go toward technical collaborators ($100k) and hydrodynamic model development through the collaboration with USGS ($100k).

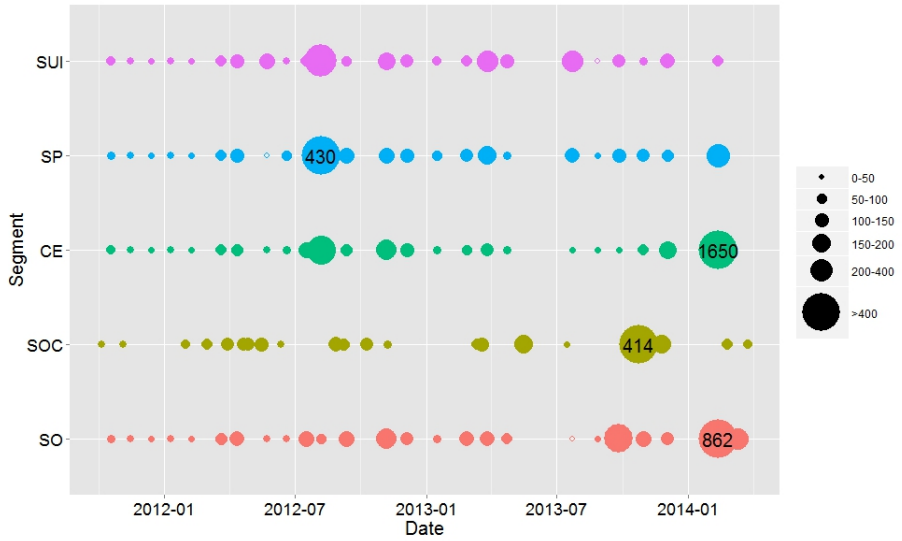
[2] http://www.sfei.org/sites/default/files/Nutrient_Modeling_Approach_draftFINAL_Jan212014.pdf


Year 1
Year 2
Year 3
Years 4-5
1. Model Set-up, including: model inputs, boundary conditions, data for calibration/validation
7. Water Quality in margin habitats: creeks, sloughs, wetlands, restored salt ponds
• Use both simplified domain models and (if necessary) more highly-resolved habitat specific models, focused on DO, phytoplankton productivity, and nutrients
• Quantitatively explore the underlying causes of low DO and role of anthropogenic nutrients
Year 6+
5. Phytoplankton community composition in specific subembayments
Year 6+
2. LSB and South Bay ecosystem response investigations
3. Suisun Bay ecosystem response investigations
Using simplified domain models: e.g., 1-box, 2-box, highly-aggregated subembayments (several to 20 boxes):
• Parameter sensitivity analysis
• Subembayment scale calibration
• Explore underlying causes of changes in response, hypothesis testing
• LSB: 3x biomass increases, fall;
• Suisun: low biomass: clams, light, residence time, NH4+
• Quantify nutrient transformations/fate at the subembayment scale
• Sensitivity Analysis to inform monitoring/field studies
4. Full Bay modeling
• Full Bay models of increasing complexity, as needed to address management questions
• Fate of nutrient plumes from individual sources
• Response under future scenarios
Year 6+
Base Community Model
6.1 Develop/Acquire hydrodynamic model output to satisfy WQ modeling needs for Years 1-2.
• Option 1: Use flexible hydrodynamic model output from CASCADE II project. Available Q2-Q3 2014. Aggregate grid for use in LSB and Suisun.
• Option 2 (backup): Invest in calibrating existing Delft3D model for 2D until Option 1 becomes available, or use UnTRIM or SUNTANS output.
Periodic updates to hydrodynamic input to WQ modeling
6.3 Collaboratively develop sediment transport within the flexible mesh model for the Bay (as needed)
Year 6+
6.2 Continue collaboratively developing hydrodynamic model within the flexible mesh Bay model including calibration/validation for additional years, faster run times, etc.
Year 6+

P.2 Develop a 3-yr monthly time-series of algal toxins and phytoplankton community composition in San Francisco Bay	Priority = HIGH
FY2015 Cost = $200,000	
Collaborators: UC Santa Cruz, USGS, SFEI	

In this study, we propose to measure algal toxin concentrations in ~300 archived water column samples collected throughout the Bay between 2011-present; additional water column samples collected during FY2015; and a limited number of bivalve samples. All of the archived water column toxin samples have co-located algal pigment samples, and have been analyzed as part of a currently-funded project, which will allow us to explore the relationship between toxin abundance, chl-a, and phytoplankton community composition.

Developing an improved understanding of the relationship between HABs/toxins and nutrients in San Francisco Bay – and ambient conditions related to toxins and HAB-forming species – are among the highest priority science and monitoring needs for San Francisco Bay. Some phytoplankton species form harmful algal blooms (HABs) that produce toxins that adversely impact both aquatic life and humans. Links between nutrients and HABs/toxins have been shown in some estuaries. However, the relationship is complex, numerous factors contribute to the probability or frequency of HAB occurrence, and there has been limited investigation to date in the Bay exploring these linkages. To better understand both the linkages between nutrients and HABs/toxins in the Bay and ecosystem condition, substantially more data on toxins and phytoplankton composition are needed. Although no HABs have been noted in the Bay over the past few decades, potentially harmful species are commonly detected in low numbers by the USGS. The frequent presence of seed organisms, and the Bay's abundant nutrients, mean that HABs could develop if appropriate physical conditions prevail (stratification, temperature), as evidenced by the Fall 2004 red tide bloom in South Bay (Cloern et al., 2005). Pilot studies (2012-present) carried out by USGS-UCSC, in collaboration with RMP (2013-present), have found that the toxins domoic acid and microcystin commonly occur throughout the Bay. These pilot studies used a



Domoic acid (DA) concentration captured by resin (ng DA/g resin). On some cruises South Bay and Central Bay were combined. SO=South Bay (including LSB); SOC = South + Central Bays; CE = Central Bay; SP = San Pablo Bay; SUI = Suisun + Lower Sacramento River. Numbers represent values of samples greater than 400 ng/g. Data: R Kudela

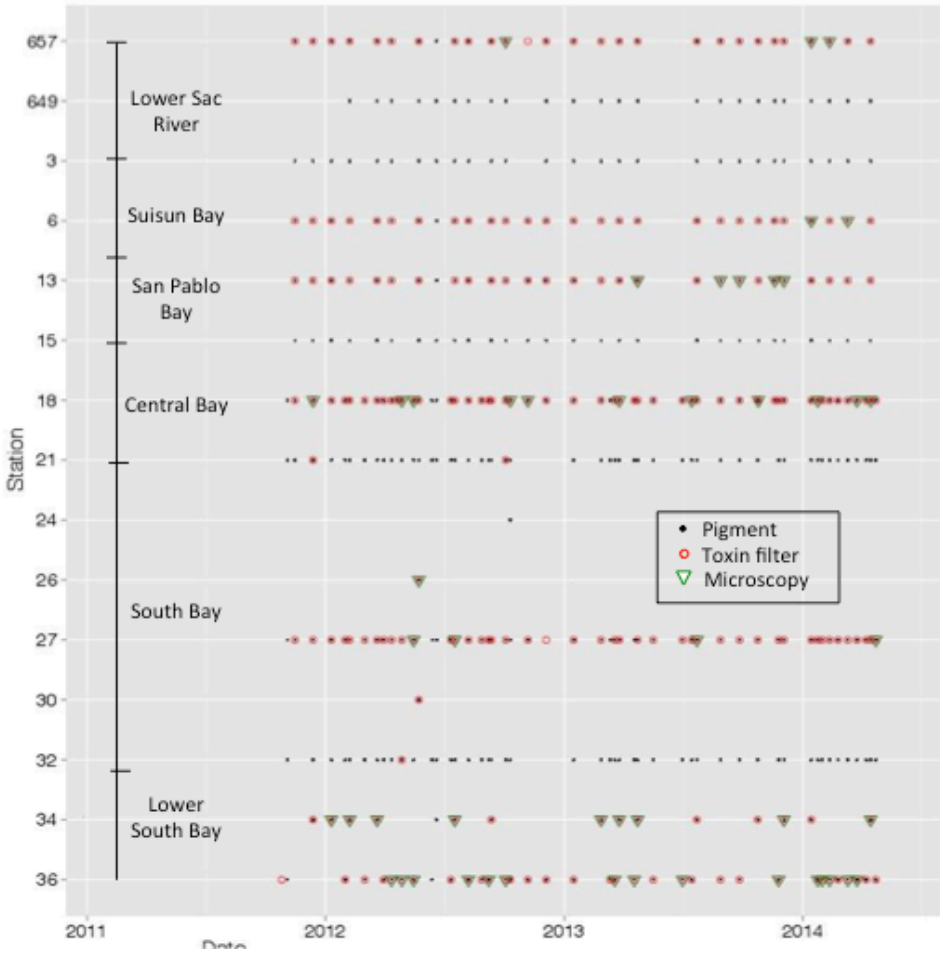
resin that binds several common toxins, and collected subembayment-integrated samples by continuously pumping water from the Bay past the resin while the ship was underway. This approach provides a cost-effective survey for toxins. However, the subembayment-integrated samples are likely too spatially-coarse to improve our understanding both about the magnitude of toxin plumes and the conditions under which toxins were created. An additional difficult with this resin-based technique is that extrapolations back to ambient concentrations are highly uncertain.

The project will achieve the following goals:

- Substantially advance our understanding about current conditions and important mechanisms in SFB with respect to algal toxins.
    - Determine how algal toxin concentrations vary seasonally and spatially, and, to some degree, how they vary interannually (over this relatively short period of record);
    - Assess how toxin concentrations compare to thresholds known to adversely impact ecological health;
    - To the extent possible, develop an improved understanding of, and testable hypotheses for, the physical/chemical/biological factors that contribute to the occurrence of higher/lower toxin abundance.
- Inform monitoring program requirements for toxin measurements, including:
    - Necessary spatial/temporal sampling resolution to adequately describe variability and to capture "events of concern" through comparison of discrete filter samples and subembayment–integrated measurements ;
    - Appropriate analytical methods (e.g., integrated resin-based samples vs. discrete locations) and optimized analytical techniques (e.g., methodologies for extracting the most relevant spectrum of toxins from a single sample).

Sample Collection and Measurement: This project will include several "Definite" (D) sets of analyses and one or more "Optional" (O) analyses. The choice among optional activities would depend both on available time and resources, and on indications from early measurements about which direction(s) would be most informative. Activities will include:

1. Measure toxin concentrations in filters collected during past or on-going monitoring at existing USGS sites
    - D.1 Archived filters collected beginning in 2008, after salt ponds were breached, through Apr 2014, generally at monthly or greater frequency, at stations in Lower South Bay (40 samples). Salt ponds are hypothesized to act as an incubator for harmful phytoplankton species.
    - D.2 Archived filters collected monthly from Nov 2011-Jun 2014 at one station per subembayment on a monthly basis (~240 samples, including 40 from Lower South Bay noted above). At all of those stations, pigment filters were also collected and recently analyzed in 2013-2014 as part of a related project.
    - O.1 Filters collected at 6-12 stations per full-Bay cruise from Jul 2014-May 2015 (100+ samples)



Locations and dates for archived toxin samples, along with co-located pigment and microscopy samples

2. Measure toxin concentrations in bivalve samples
    - D.3 Archived samples from Mussel-watch sites, RMP sampling, and other relevant past sampling activities (12 samples from 2012, 10-15 samples from 2014)
3. As part of other planned field activities in Fall 2014 (P.8), collect filter samples at 6-9 sites on a monthly basis. (2-3 sloughs, 3 sites per slough, and 1 station at the down-estuary end of Coyote Creek; Aug-Nov = 30-40 samples)
    - O.2 These samples could be collected during other fieldwork and would not require their own field campaign. For any newly-collected samples, pigment samples will also be analyzed.

Deliverables

- Progress update at 6 months
- Technical report at project's completion

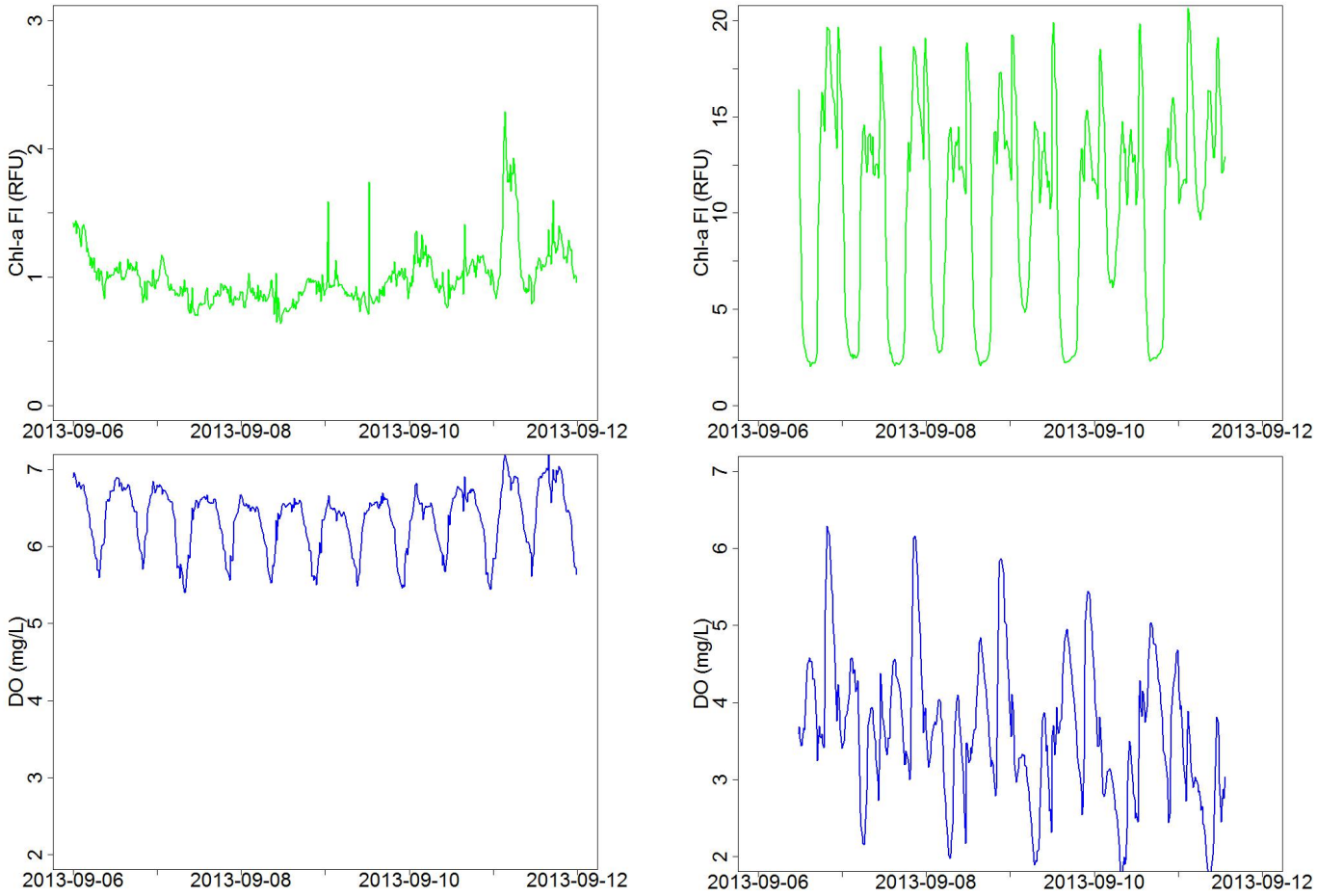
Budget

Funding will support a 1-year postdoc at UCSC to carry out sample analysis, data interpretation, and report preparation; analytical costs (lab supplies and consumables); collaborator support/supervision (total: $170k); and SFEI staff support (30k).

P.3 Moored sensor program development/expansion	Priority = HIGH
FY2015 Cost = $340,000	
Collaborators: SFEI, USGS-Sac, USGS-Menlo, SanJose	

While scientific studies and monitoring by the USGS, DWR-EMP, and RMP provide us with several decades of water quality data in the Bay, most of that data has been collected at weekly-monthly time intervals. Phytoplankton biomass and related parameters such as nutrients, dissolved oxygen, and suspended sediments vary strongly over much shorter time scales (hours) due to diel cycles, mixing, biogeochemical processes, and tides. To better assess the Bay's condition, and to collect high-frequency data to calibrate water quality models, the RMP began funding a moored sensor network in 2013. This proposed study will: maintain existing stations; add one additional station; and continue data analysis and on-line data. visualization/download work; and inform on-going monitoring program development.

In Summer 2013, sensors for chl-a, dissolved oxygen, turbidity, temperature and other parameters were deployed at 3 stations in Lower South Bay and South Bay in



Chl-a (relative fluorescence units; RFU) and Dissolved Oxygen (mg/L) at Dumbarton Bridge and Alviso Slough (4km upslough from confluence with Coyote Creek) over a 5 day period. At both sites, chl-a fluorescence varied tidally, but maximum values were 10-15 times greater at Alviso than Dumbarton (note different y-axis scales. Although the fluorescence signal is prone to interferences, the large differences here suggest that maximum phytoplankton biomass at Alviso (~50 µg/L) was substantially greater than at Dumbarton (3-5 µg/L), and emphasize the strong spatial and temporal variability in chl-a. DO also varied tidally at both sites. The DO minima at Dumbarton occurred at low tide, which could be the result of low DO draining shallow margin habitats mixing with open-bay water and moving past the sensor. DO was substantially lower at Alviso than Dumbarton and exhibited a multiple strongly-periodic maxima and minima.

collaboration with the USGS's sediment group, who already have infrastructure for continuous monitoring for a subset of parameters in these areas. One of the sites, the Dumbarton Bridge, telemeters data every 15-minutes to a server, which will allow for eventually viewing data in near-real time. Year 1 efforts focused on installation, developing capacity for moored sensor maintenance and operation (including creating procedures for maintenance and data processing/management), and interpreting data to identify sites for network expansion. At present, moored sensors have been installed at Dumbarton Bridge, San Mateo Bridge, and in Alviso Slough.

In FY2015, we propose to add a 4th station in South Bay or Lower South Bay. Potential locations include Coyote Creek near where it enters Lower South Bay, or on a channel marker in the southern quarter of Lower South Bay, based on the strong north-south gradients in nutrients, chl-a, and suspended sediments in Lower South Bay. To allow for improved estimates of chl-a and phytoplankton biomass, we will design and execute experiments to better constrain the chl:fluorescence relationship and estimate uncertainty. We will also add telemetry to new and existing stations, where possible given site-specific logistical constraints. Due to increasing data, we will also invest further in developing standard procedures for data management and processing, including automation where possible, and developing a database. We will also further develop a web-accessible data visualization and download tool for accessing real-time and historic sensor data (pilot project begun in year 1). The goal is for this web interface to host data from multiple programs (SFEI/RMP, 2 USGS groups, and possibly others) and allow for intuitive data visualization, including viewing time series data from multiple stations and multiple parameters simultaneously.

Deliverables

A progress report will be submitted June 2015. In that report, we will analyze data to inform system understanding, identify lessons learned from year 2 of the program, and make recommendations for moored sensor priorities in year 3.

Budget

The budget for this task for FY2015 is $340,000. $250,000 of this is for personnel support across a range of tasks: sensor installation, maintenance and operation; data processing and management; data visualization; and data analysis and reporting. $70,000 will be used to purchase equipment for a 4th station, including telemetry, as well as to purchase one additional nitrate sensor. $20,000 will be used for field logistics support for our collaborators at USGS-Sacramento.

P.4.A Analysis of historic data to inform monitoring program development, assessment framework development, and synthesis/mechanistic interpretations **P.4.B On-going development of monitoring program structure**	**Priority = HIGH**
FY2015 Cost = $270,000	
Collaborators: SFEI, UC SantaCruz, USGS-Menlo, RTC, other technical advisors, SCCWRP	

P.4.A Analysis of historic data to inform monitoring program development, assessment framework development, and synthesis/mechanistic interpretations

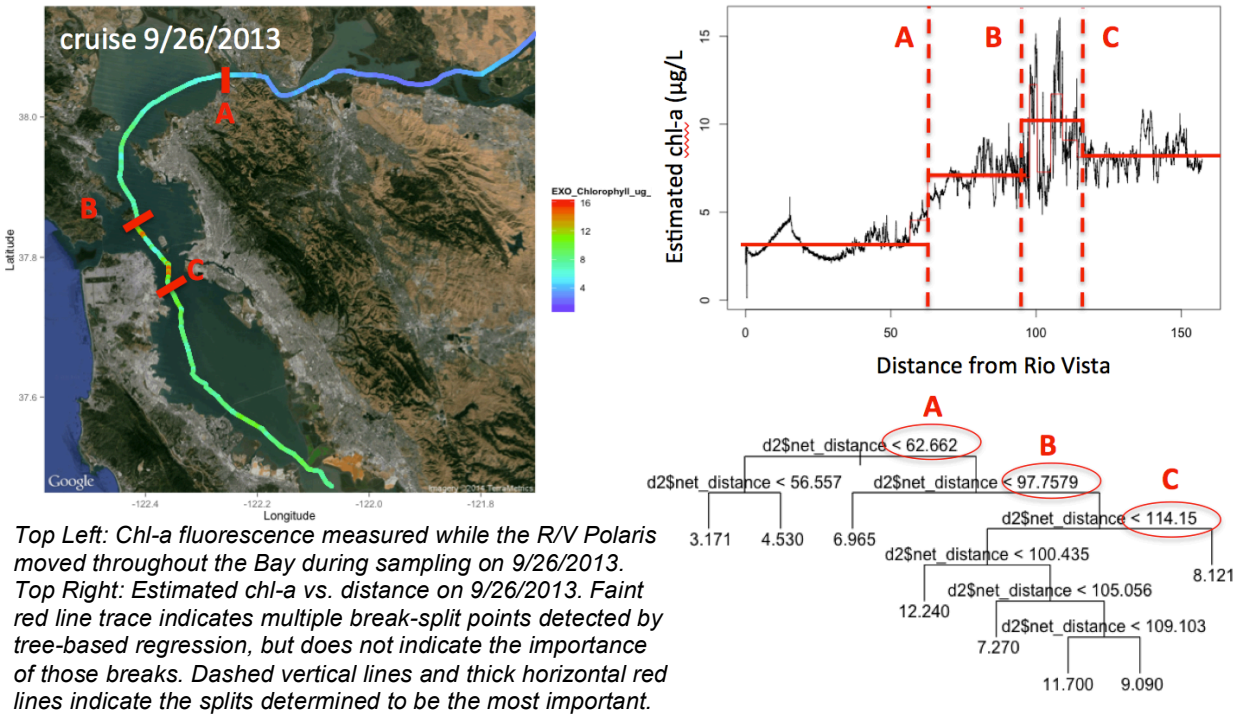
Summing over the many years of anticipated water quality monitoring ahead, the monitoring program will likely account for the largest portion of overall nutrient program costs. Therefore, there is considerable benefit to carefully planning and designing the most efficacious yet cost-effective program. We are also fortunate - for monitoring and assessment framework development and on-going synthesis/mechanistic interpretations - that long-term systematically collected monitoring data (~40 years) exist, plus data from a number of special studies, that can be extensively mined.

Through this project we will use historic monitoring data and other more focused data sets to explore key questions that technical advisors identified as important for informing monitoring program design, assessment framework development, and our overall understand of ecosystem response to identify data gaps and priority studies. Example questions include:

1. What is the optimal spatial/temporal resolution of sampling?
    a. What sampling spatial resolution is needed along the longitudinal axis of the Bay to capture most of the variability across a range of relevant parameters, seasons, etc.?
    b. What sampling spatial resolution is needed laterally, as a function of subembayment and season?
    c. In South Bay, what is the minimum temporal sampling during important periods (e.g., spring blooms)?
    d. What are characteristic scales (space/time) of phytoplankton blooms in Suisun Bay?
    e. Where should moored sensors be placed? What is the optimal blend of ship-based sampling and moored sensors?
2. Identifying spatial/temporal resolution of priority “events” (i.e., what are we trying to detect?)
    a. What levels of toxin concentration are problematic? How do these translate into spatial, concentration, and duration scales?
    b. What changes in phytoplankton composition or occurrence of potentially harmful species do we need to detect?
    c. What sampling resolution (lateral, longitudinal) is required to capture the priority “events” described above?

3. How has phytoplankton community composition in South Bay, Central Bay, and Lower South Bay changed over the past 20 years? What changes in physical, chemical, or biological drivers can explain those changes?
4. How frequently (and under what conditions) does the relationship used to estimate productivity in SFB (based on chl-a concentration and PAR, i.e., Cole and Cloern 1987) need to be validated/calibrated?

As each of these questions is explored, the results will be summarized as technical reports and, where appropriate, peer-reviewed publications. These technical reports will either be stand-alone documents, or included as sections within other reports related to monitoring program development or assessment framework development.



Top Left: Chl-a fluorescence measured while the R/V Polaris moved throughout the Bay during sampling on 9/26/2013. Top Right: Estimated chl-a vs. distance on 9/26/2013. Faint red line trace indicates multiple break-split points detected by tree-based regression, but does not indicate the importance of those breaks. Dashed vertical lines and thick horizontal red lines indicate the splits determined to be the most important. Bottom Right: This tree illustrates the relative importance of splits, with A, B, and C representing the largest splits. Similar analyses will be carried for multiple dates/seasons, multiple parameters (chl-a, turbidity, T, salinity, nutrient concentrations) to identify the optimal spacing of stations along the Bay's axis.

P.4.B On-going development of monitoring program structure

In March 2014, we completed a draft monitoring program development plan with input from a team of technical advisors. That plan is being circulated to stakeholders and other collaborators in June 2014 for additional input. The report lays out a number of priority activities – from analysis of existing data to inform optimal program design (spatial/temporal sampling frequency) to identifying a set of tiered recommendations for program implementation (new analytes, methods, costs, etc.).

During FY 2015, 2 meetings will be held with technical advisors, and 2 meetings with the Nutrient Technical Workgroup to obtain feedback from a group with a range of perspectives. With guidance from the technical advisors and the NTW we will

undertake the highest priority activities, using those recommended in the program development plan as a starting point.

Deliverables

Interim progress reports and updates will be produced in the form of powerpoint presentations or memos in advance of technical advisor or NTW meetings. Meeting summaries will also be prepared. An annual progress report on program development will also be prepared, bringing together results/recommendations for program structure (based on data analysis) with other programmatic advances (e.g., new analytes, methods, costs, tiers). An additional option is to produce an Nutrient Science Program annual report that summarizes progress on multiple fronts, describes monitoring-related observations (status, trends), and presents noteworthy results from special studies. If this product is viewed as a high priority, the budget/planning for this task may need to be reevaluated.

Budget

Funding will support staff effort on data analysis, program development, and report preparation (~235k), technical advisors/collaborators (35k).

P.5 Stratification scenarios for DO and HABs	**Priority = HIGH**
FY2015 Cost = $80,000	
Collaborators: UC Berkeley, SFEI, SCCWRP, USGS-Menlo	

The frequency and duration of water column stratification events in SFB is an important determinant of whether low DO and harmful algal blooms could become problems in deep subtidal habitats, in particular in South Bay and Lower South Bay. Initial worst-case-scenario calculations indicate that phytoplankton blooms of realistic magnitude could translate into low DO in bottom waters. However, those calculations assume that the water column stratifies for a long enough interval that the bloom can develop, and remains stratified long enough to allow low DO to develop and persist such that adverse impacts occur. Prolonged stratification also creates conditions under which HABs can form: e.g., the Fall 2004 red tide bloom in South Bay (Cloern et al, 2005). Under current conditions, stratification in San Francisco Bay is known to be variable at a wide range of timescales due to the strong tidal forcing and seasonal cycle in river flows and associated density gradients. This study will examine the relation and competition between the drivers that cause and break down stratification, assess the potential for this relationship to change such that stratification persists long enough to cause adverse impacts. More specifically, this study will address the following questions:

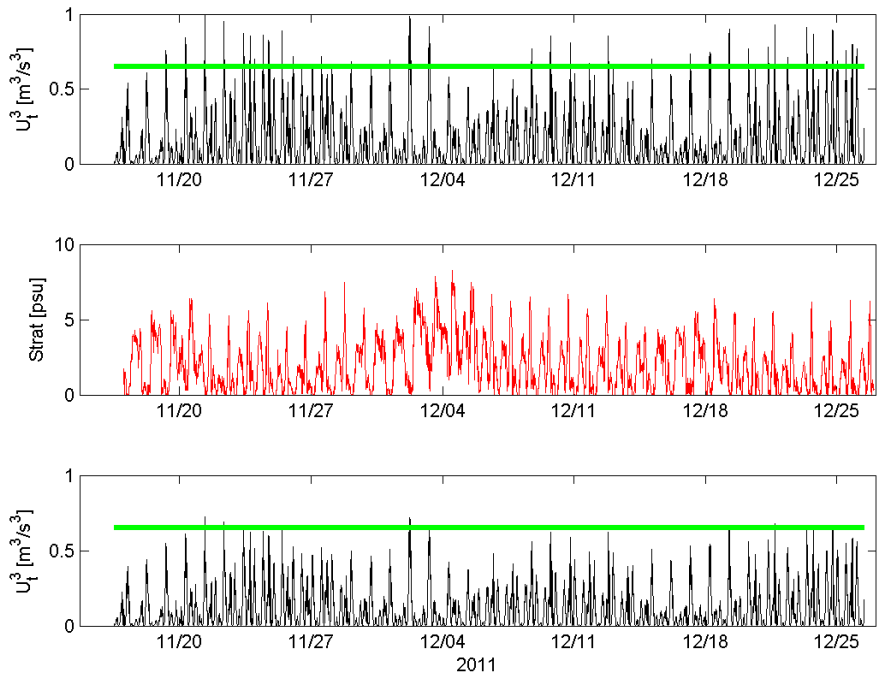
1. How frequently does stratification develop in different areas of the Bay and for how long does it typically persist?
2. What combinations of physical forcings lead to the set-up and break-down of stratification in key areas of SFB? What regulates the magnitudes of these opposing forcings, in particular around periods when shifts between stratified and destratified tend to occur? What could alter the magnitudes of these forcings?
3. How would changes in forcings translate to changes in stratification duration as determined through simplified domain modeling?

Analysis of long-term observations from Suisun Bay and South Bay will be combined with highly detailed shorter observation periods from the same basins to establish current stratification conditions. A focus of this analysis will be on establishing the relationship between stratifying processes that vary on seasonal, hydrographic (i.e., freshwater flow) event and tidal (semi-diurnal, diurnal and spring-neap) timescales and mixing processes that act to maintain an unstratified water column. We anticipate that both basins experience tidally-periodic stratification, with some persistence across multiple tidal cycles occurring during neap tides. We will explore the likelihood of stratification persisting for a spring-neap period (14+ days) under current conditions. The persistence of stratification across the spring-neap cycle is a critical threshold, since once stratification persists across one spring-neap cycle, it is likely to persist across multiple, potentially resulting in stratification that lasts for months.

To evaluate how future scenarios of change will influence the variation of stratification, we will build on the observational analysis using a combination of theoretical and numerical analysis. The theoretical analysis will compare stratifying and destratifying processes using dimensionless groups and evaluate the probability of

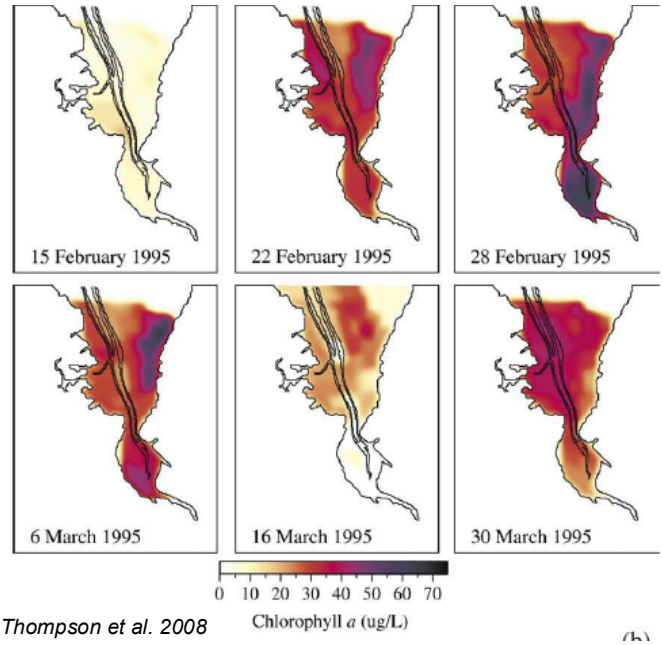
various lengths of stratification persistence under scenarios of climate change. Combining this analysis with simplified numerical models, which resolve the vertical structure of the density and flows (i.e., for a water column), will allow us to explicitly evaluate future scenarios and determine under what set of future conditions stratification may persist across the spring-neap cycle. Future scenarios will probe variation in stratification that may arise from changes to (a) freshwater flows/density gradients; (b) shorelines (whether by management action or sea level rise) and associated changes to the tides; (c) atmospheric heating; and (d) wind mixing. The future scenarios will be described by changes in tidal forcing (informed by considering scenarios for shoreline change; and analysis of sea level rise and inundation performed under separate funding) and alterations to the local buoyancy forcing (salinity gradients induced by freshwater flows). The balance between stratifying and destratifying processes will be evaluated using the numerical water column analysis with a particular focus on the threshold for stratification to persist across an entire spring-neap cycle.

To illustrate the importance of these analyses, preliminary analysis of data from a Suisun Bay site indicates the potential for long-term persistent stratification under future scenarios. The top panel presents a metric of mixing (turbulent velocity cubed) and the second panel shows the co-located stratification (top-bottom salinity difference). The stratification is seen to be strongly periodic tidally, but a period of persistent stratification develops around December 4. Based on this stratification record, an estimated threshold for destratification is overlaid on the top panel (green horizontal line). In the bottom panel, the same comparison is made as in the top panel, but now with the tidal velocities uniformly reduced by 10%. If the threshold for destratification remains the same, even this minor change in tidal forcing is expected to lead to stratification that would persist for 2 weeks or more, as only a few tidal periods have sufficient energy to pass the threshold for destratification.



P.6 Apply hydrodynamic modeling output to inform monitoring program design	**Priority = MED**
FY2015 Cost = $120,000	
Collaborators: SFEI and collaborators	

The vast majority of water quality data collection in San Francisco Bay occurred in deep habitats along the Bay's main channel. However, it is well known that phytoplankton blooms commonly begin along the Bay's broad shoals. The Bay is generally considered to be a light-limited system throughout most of its area and much of the year. Along the shoals, the shallow water column allows for higher light levels, and higher phytoplankton growth rates. Other processes, such as biogeochemical transformations at the sediment:water interface, likely also have a more pronounced effect on water column chemistry than in deep subtidal areas.



Thompson et al. 2008

Tidal and wind-driven mixing also exert strong influences on the measured concentrations of various constituents. In that sense, the water mass at any location in the Bay is actually a time- and space-integrated sample, a mixture of water masses from different locations that contribute unique amounts to the final concentration of constitute. Therefore, designing the optimal monitoring program – one that captures the desired degree of spatial and temporal variability in key parameters and is capable of detecting "events of concern" (e.g., a phytoplankton bloom of a certain size; a plume of algal toxins) – will require hydrodynamic modeling.

Motivated by a similar goal as P.4, this project will combine output from existing hydrodynamic simulations with event scenarios or historic water quality data to achieve the following goals:

1. Introduce events of concern, such as major blooms or algal toxin events, and identify the optimal sampling scheme to reliably capture a range of priority events
2. Using backward trajectory modeling, identify the sources of water (space, time) that contributed to ambient concentrations at existing stations along the Bay's main channel; constrain the originating conditions that could have created observed conditions; and reveal zones that are poorly captured by the current program design.

Existing hydrodynamic model outputs that could be considedered include 1-2 years of Bay-wide SUNTANS simulations, or multiple years (up to 20) of output from UnTRIM.

P.7 DO objectives (lit review, data analysis)	**Priority = HIGH**
FY2015 Cost = 100,000	
Collaborators: SCCWRP, SFEI, technical advisors	

This project will be a data analysis and literature review study focused on identifying what DO levels are protective beneficial of beneficial uses. It will address the following questions:

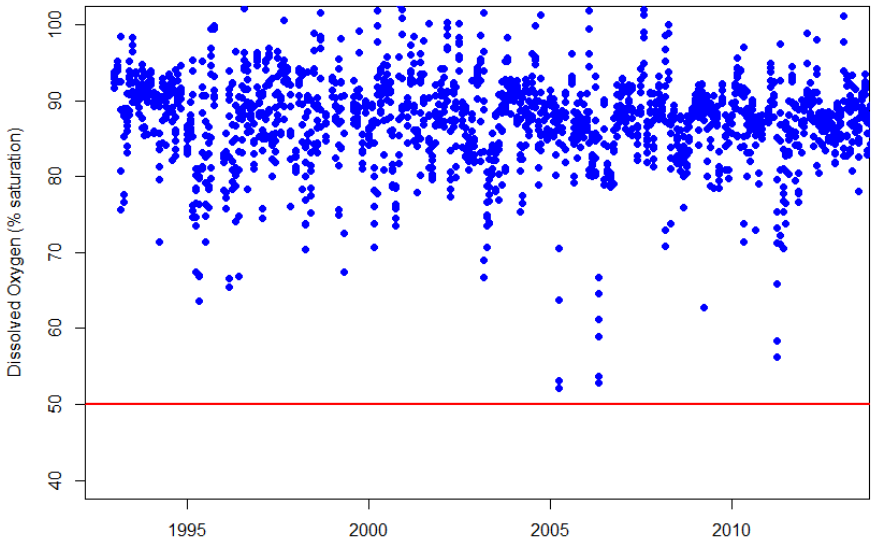
- What beneficial uses, and more specifically, what aquatic organisms are we aiming to protect in various habitats (deep subtidal, sloughs, creeks, wetlands)?
- What levels of DO are optimal or protective for those beneficial uses and organisms during life stages when they utlize those habitats?
- What low DO conditions would adversely impact those habitats/organisms - DO concentration, duration of events, spatial extent, seasonality (eg., relative to critical life stages)?
- How have other estuaries or coastal zones addressed the issue of site-specifc DO criteria, and “naturally” low DO in margin/shallow habitats?

The San Francisco Bay Regional Water Quality Control Board has secured $100,000 for this project, will support SCCWRP and SFEI staff and technical team for data analysis, literature review, and report preparation.

P.8 Dissolved oxygen in shallow margin habitats	**Priority = HIGH**
FY2015 Cost = 300,000 This is a 1-year funding request for a project that would likely continue over 2+ years.	
Collaborators: SFEI, SanJose Santa Clara Valley Wastewater Agencylester, USGS-Sac	

This proposed project will install, maintain, and interpret results from a several-station network of continuous monitoring stations for DO and other parameters in shallow margin habitats (creeks, sloughs) in Lower South Bay to assess condition with respect to DO and inform our understanding of major drivers.

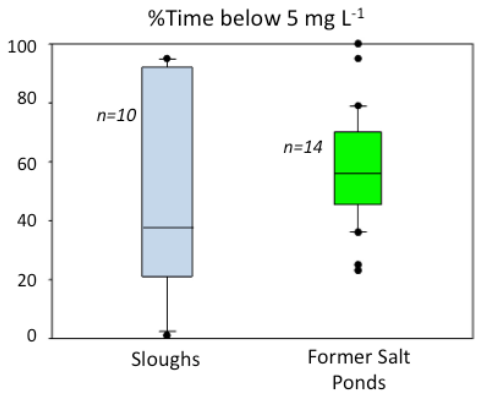
Low dissolved oxygen (DO) is a common symptom of excessive nutrient loads to estuaries and other water bodies, and results from oxygen consumption during

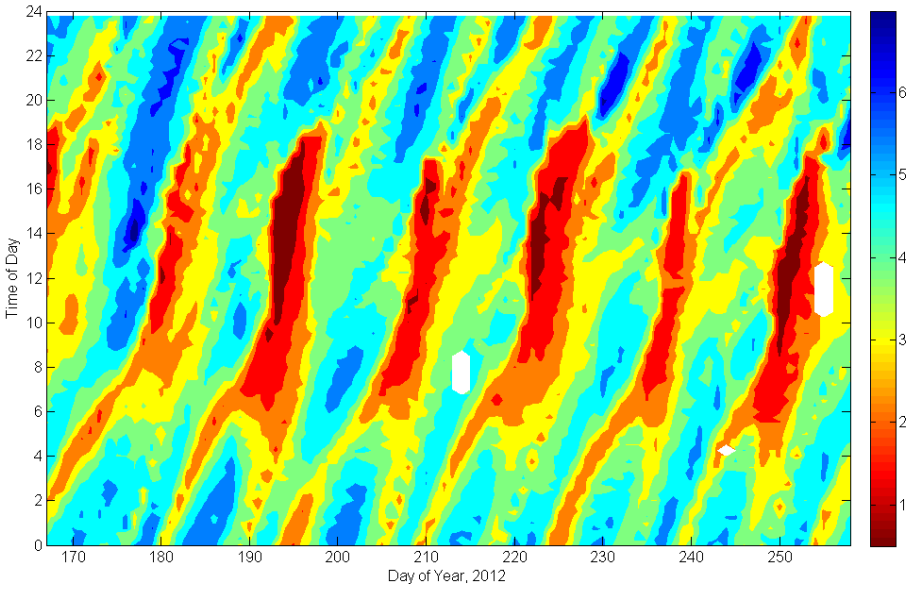


DO %saturation in bottom waters in deep subtidal areas at all USGS stations south of the Bay Bridge, 1993-2013. 100% saturation corresponds to 8.5±1.5 mg/L depending on temperature and salinity.

microbial degradation of organic matter (e.g., phytoplankton). Because of its well-established mechanistic link to nutrients, dissolved oxygen concentration is among the likely indicators of nutrient-related ecosystem health in San Francisco Bay. Most data on dissolved oxygen concentrations over the past ~20+ years have been collected in deep subtidal habitats, and DO concentrations, in general, have substantially exceed the Basin Plan criterion of 5 mg/L. Considerably less data is available for shallow margin habitats in San Francisco Bay, including sloughs, creeks, tidal wetlands, and former salt ponds undergoing restoration. Although these areas represent important habitats for aquatic organisms at certain life stages, there is no coordinated, systematic monitoring across a representative set of sites.

A recent survey of existing continuous DO data collected over a 12 year period by assorted programs in South Bay and Lower South Bay margin habitats showed that DO was frequently below 5 mg/L (40% and 55% of the time, averaged across sites, in slough and former salt ponds, respectively). Low DO occurs naturally in margin habitats like wetlands and sloughs. However there is currently insufficient information to characterize the frequency, duration, and severity (how low) of events, or to explore the underlying causes (importance of natural vs. anthropogenic factors). One excellent data set, collected in Alviso Slough demonstrates that low DO exhibits strong periodicity and persists at levels <2-3 mg/L for 12 hours or more over several days. This station is, however, 2.5 miles upslough from the confluence with Coyote Creek, and the spatial extent of low DO there, and how representative this condition of other sites, are unknown.





DO (contours; mg/L) as a function of date and time of day, Jun 15 –Sep 14 2012. Sensor was ~2 ft above the bottom. Low DO occurred during strongly periodic windows that coincided with weak neap tides. During these windows, DO was lowest during daylight hours when oxygen production would otherwise be expected, and DO increased during highest tide of the day, which occurred during the late evening. One hypothesis that can explain the daily pattern is that stratification developed due to low tidal mixing energy during these weak neap tides, and oxygen was rapidly consumed in the bottom layer due to sediment oxygen demand. An alternate hypothesis is that the entire water column had low DO concentrations, and the low DO water mass was pushed further upstream during high tide. Data: M Downing-Kunz; SFEI 2014.

Funding is being requested for Year 1 of a 1-2 year field study to determine the frequency, duration, and spatial extent of low DO in representative margin habits (sloughs, creeks) using moored sensors complemented by field sampling/calibration. This project's major goals, include:

1. Characterize temporal (tides, diel) and spatial patterns in DO and related parameters across a sites having a representative range of physical/biological characteristics;
2. Determine the frequency and duration of events with DO < 5 mg/L (and other relevant thresholds);
3. Through additional field measurements (vertical profiles during longitudinal transects), characterize the spatial extent of noteworthy events or common conditions,

4. Through the use of basic modeling and field data, semi-quantitatively test hypotheses for why low DO occurs.

Instruments will be installed at up to 6 sites, and will require maintenance and data download approximately every 2-4 weeks, depending on the time of year and rate of biofouling. During regular maintenance trips and some special field trips (to coincide with events), DO will be measured in vertical profiles at stations along longitudinal transects in creeks and sloughs to spatially-characterize conditions.

Ideally, 2-3 of the sites for this project would be installed in August-September 2014, since low DO is most pronounced in Summer/Fall.

Deliverables

Progress updates will be given in the form of presentations and meeting materials at technical team meetings and NTW meetings. A final technical report will be produced at the project's completion.

Budget

Funds will be directed toward instrumentation and equipment (110k), staff time for maintenance and data interpretation (150k), and field support for USGS (40k).

P.9 Additional Monitoring at current main channel stations in SFB, USGS cruises: phytoplankton taxonomy, nutrients	**Priority = HIGH**
FY2015 Cost = $100,000	
Collaborators: USGS, SFEI/RMP	

Currently, the USGS analyses samples for phytoplankton composition on only a limited number of stations, and only under certain conditions (typically only when chl-a exceeds 5ug/L), typically <5 stations per full-Bay cruise. Much more information – and collected consistently at a defined set of stations – is needed on community composition to determine if adverse shifts in phytoplankton composition are occurring, or harmful species are present at concerning levels, and to explore the underlying mechanisms leading to such shifts.

Similarly, nutrients are not a core part of the USGS research program and "optional"; therefore the full suite of analytes (i.e., no TN or TP) is not measured and spatial/temporal frequency is lower than is needed.

Deliverable and Budget
This project would support the measurement of 300 sets of nutrient analyses ($35k) and taxonomy on 300 samples for phytoplankton community composition and biovolume ($65k).

The results of these analyses would be made publicly available through USGS's website.

P.10 Physiological Assessment of the "Bad Suisun" Phenomenon: Light and Nutrient Interactions	Priority = HIGH
FY2015 Cost = $60,000	
Collaborators: UCSantaCruz, AMS	

Ammonium (NH_4^+) inhibition of phytoplankton productivity in Suisun Bay has been inferred from increases in chlorophyll during mixed-assemblage incubations, coinciding with depletion of ammonium and increasing use of nitrate during the incubation period (Dugdale et al. 2007, Parker et al. 2012). These results may be confounded by changes in irradiance, growth rates and species composition between ambient and test conditions. To tease apart environmental and community effects from physiological effects, and to determine if elevated concentrations of NH_4^+ directly cause a decline in primary production under controlled conditions, this project will test 1) the NH_4^+ tolerance, 2) the influence of differences sources of nitrogen (N), and finally 3) the relative importance of N sources versus irradiance in regulating growth of individual phytoplankton species endemic to Suisun Bay.

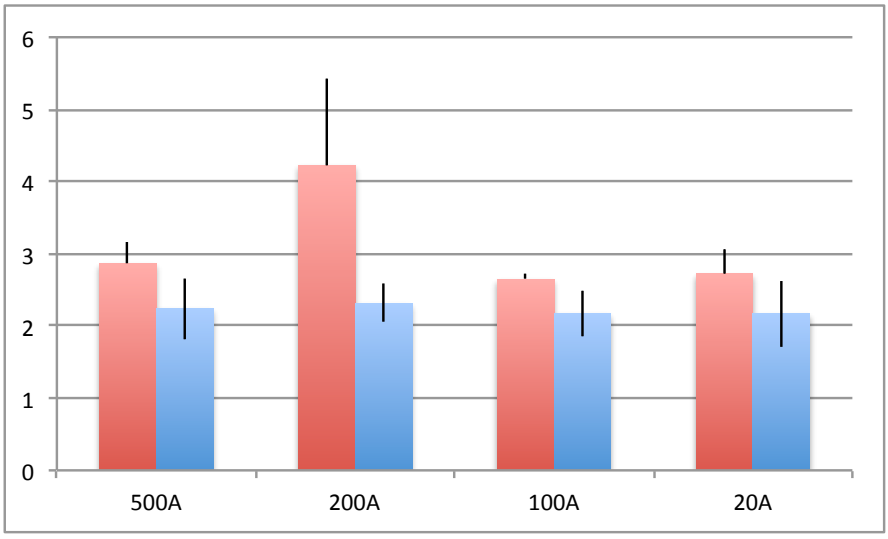


Figure 1. Carbon fixation (μg C μg Chl a-1 hr-1 on the y-axis in the diatom *Thalassiosira weissflogii* as a function of NH_4^+ (red bars) or NO_3^- (blue bars) at concentrations of 20-500 μmoles L^{-1} on the x-axis.

To date, eight species of phytoplankton from Suisun Bay have been isolated into pure culture. Only three of these have been tested for their tolerance to NH_4^+, as well as for growth on NH_4^+ relative to nitrate (NO_3^-). In one of the tested species, the diatom *Thalassiosira weisflogii*, the rate of carbon fixation was similar when grown on NH_4^+ compared to NO_3^-, and optimal NH_4^+ concentration for growth was 200 µmoles NH_4^+ L^{-1}. No inhibition of growth occurred in the range of NH_4^+ concentrations (20-500 µmoles L^{-1}) tested here (Figure 1). We would like to test the remaining five species for their NH_4^+/ NO_3^- tolerance levels, and to perform irradiance-nutrient interaction experiments on three of the eight species isolated. One of the eight species of phytoplankton isolated is the diatom *Thalassiosira pseudonana*. This diatom is also in culture at the National

Center for Marine Algae (NCMA) and has had its genome sequenced (Abrust et al. 2004). It was originally isolated in 1958 from Moriches Bay in Long Island, NY, and we would like to compare the tolerance levels of the freshly isolated *T. psedonana* strain from Suisun Bay with that from NCMA to determine whether NH_4^+ tolerance levels are similar or dissimilar in these two cultures. This comparison will give us information on how large a role acclimation to culture conditions over a period of more than four decades may play in modulating the NH_4^+ tolerance thresholds of algae.

Using a similar rationale, we would like to isolate two-four species of phytoplankton from the southern part of San Francisco Bay (South Bay) in order to test their NH_4^+ tolerance thresholds. Comparison of tolerance levels between species already isolated from Suisun Bay with those from South Bay will tell us whether phytoplankton tolerance levels are similar or dissimilar in species from the two endpoints of the Bay. Both the comparison of phytoplankton isolated from Suisun with a species in the NCMA culture collection, and with species from South Bay, will help us understand whether NH_4^+ tolerance thresholds are largely genetically determined and/or how much a role acclimation to different regions and conditions play. These comparisons between literature, cultures and endpoints of the Bay will provide a mechanistic understanding of the interactions between NH_4^+ concentration and phytoplankton productivit, information that is necessary to make sound management decisions regarding the degree to which nutrients forms and concentrations exert negative control over the food web in Suisun Bay.

P.11 Contribution to shared Research Vessel Purchase, in collaboration with USGS and other potential partners	**Priority = HIGH** (but may not be possible this year)
FY2015 Cost = 400,000	
Collaborators: USGS, SFEI, multiple partners	

The USGS research vessel needs to be retired sometime within the next 2 years. USGS has a long-term personnel and operation budget to continue supporting a vessel and associated research and monitoring activities. However, USGS is limited in its access to funds to purchase another research vessel.

USGS has signaled its interest in partnering with organizations affiliated with the Nutrient Steering Committee on the purchase of a replacement research vessel. Contributing to the research vessel's purchase would secure the continuity of the 40-year water quality record for the Bay. USGS would continue docking, maintaining and operating the vessel. From a long-term (10 year) strategic and financial standpoint, contributing to the vessel purchase would ensure priority future research vessel use that could amount to a large cost savings for the region.

While directing funds toward this purchase may not be feasible with the current FY2015 budget, this is an important opportunity to ensure data collection continues through a federal-regional partnership. It is recommended that this remain a high-priority topic for discussion during the first half of FY2015, and that the Nutrient Steering Committee consider options for identifying or raising funds to support this collaborative effort.

P.12 Other targeted mechanistic studies exploring the role of nutrients in shaping phytoplankton community composition (including HABs), causing decreased primary production, or other effects	**Priority = MED** (wait for FY2016)
FY2015 Cost = 200,000	
Collaborators: xxx	

This project would test hypotheses of N:P, high NH4, and high NO3 on phytoplankton community, individual cell composition, etc. as one step along the path of evaluating whether these effects are occurring, and assessing their relative importance alongside other drivers.

While more studies on this topic will likely be needed to inform management decisions, given the number of recently completed (but still being written up) and on-going studies on this topic in the Suisun/Delta, it is proposed that no additional studies be sponsored during FY2015 from the Nutrient Steering Committee resources.

P.13 Fish/benthos field investigations in margin habitats to inform site specific DO objectives	**Priority = MED** (wait for FY2016)
FY2015 Cost = 200,000/yr, multi-year study	
Collaborators: UCDavis, SCCWRP, SFEI	

This project would conduct fish/benthos surveys in Lower South Bay (open waters) and in slough/creek habitats to identify species abundance and richness. The work would help inform several of the questions raised in P.7 related to habitat suitability with respect to DO for supporting fish and benthos. DO and T data would also need to be collected.

This project is a ultimately a high priority for determining if current conditions are supporting the expected habitat requirements of important species. Given budget constraints, this multi-year project could begin in FY2016. Starting in FY2016 would also allow DO data collected in FY2015 through P.8. to inform sampling design (and a continuation of P.8 during FY2016 would provide the necessary DO data to accompany biota survey data). However, if additional resources become available, the startup of P.6 and P.13 during the same year could allow for considerable overall cost savings.

P.15 Science Coordination/program management	**Priority = HIGH**
FY2015 Cost = 200,000	
Collaborators: SFEI	

This project supports science coordination across projects, coordination with Nutrient Steering Committee, regulators and stakeholders, outreach, project management, contract management, and basic reporting. Funding would support 40% the Nutrient Science Program Lead Scientist (the remainder of support for the Lead Scientist is included within individual projects) and other SFEI staff for program management.

As the Nutrient Science Program moves into its second (first official) year and the number of work products and general progress increase, it may be important to begin generating an annual report – to serve as a progress report and to disseminate information to targeted audiences (managers, regulators, politicians). In particular, the editorial committee of the *State of the Estuary* has inquired whether the Nutrient Science Program could take the lead an effort developing the nutrient section during FY2015 and FY2016 (report publication date in FY2016). The Nutrient Science Program is well-positioned to take on that role. However, guidance is sought from the NSC, both about whether this is indeed an appropriate role and how it ranks among other priorities. Note: Costs associated with either an annual progress report or the *State of the Estuary* effort have not been included in the above budget.

P.16 External Review	**Priority = MED/HIGH**
FY2015 Cost = 50,000	

Convene an external advisory panel to review key aspects of the Nutrient Science Program and key work products (science plan, etc.), hold meeting with the NSC, stakeholders, and collaborators/experts.

The question here is not whether external review is important. Instead the question is whether this should be carried out first in FY2015 or FY2016.

Approximately $30k from a FY2014 contract with BACWA for coordinating external review is being carried forward to FY2015,

November 2012

San Francisco Bay Nutrient Management Strategy

San Francisco Bay Regional Water Quality Control Board

1. Is SFB experiencing nutrient-related impairment, or is it likely to in the future?
   - What types of impairment?
   - What forms of nutrients?
   - What future scenarios?

2. What are the major nutrient sources?
   - POTWs ?
   - stormwater ?
   - agriculture ?

3. What loads/concentrations are protective?
   - most sensitive endpoint ?
   - transport, mixing ?
   - reactions (transformations, losses) ?

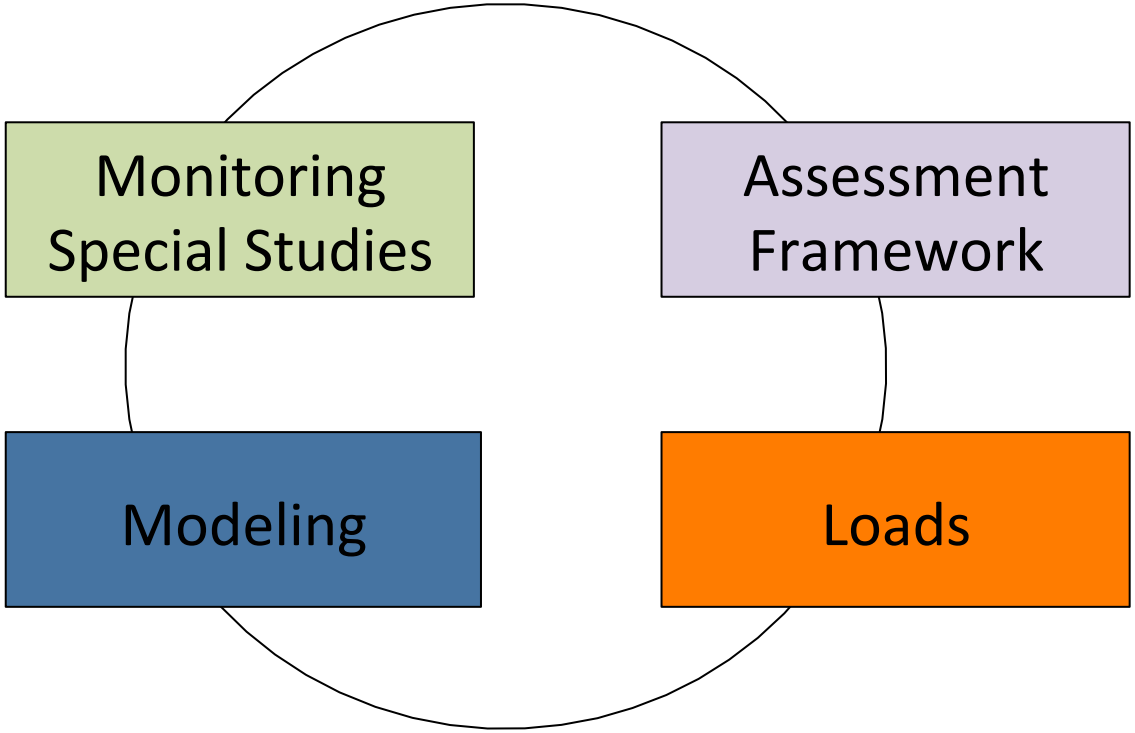
4. What reductions will protect ecosystems?
   - transport, mixing, reactions ?
   - benefit/cost ?

November 2012

San Francisco Bay Nutrient Management Strategy

San Francisco Bay Regional Water Quality Control Board

Nutrient Science Program

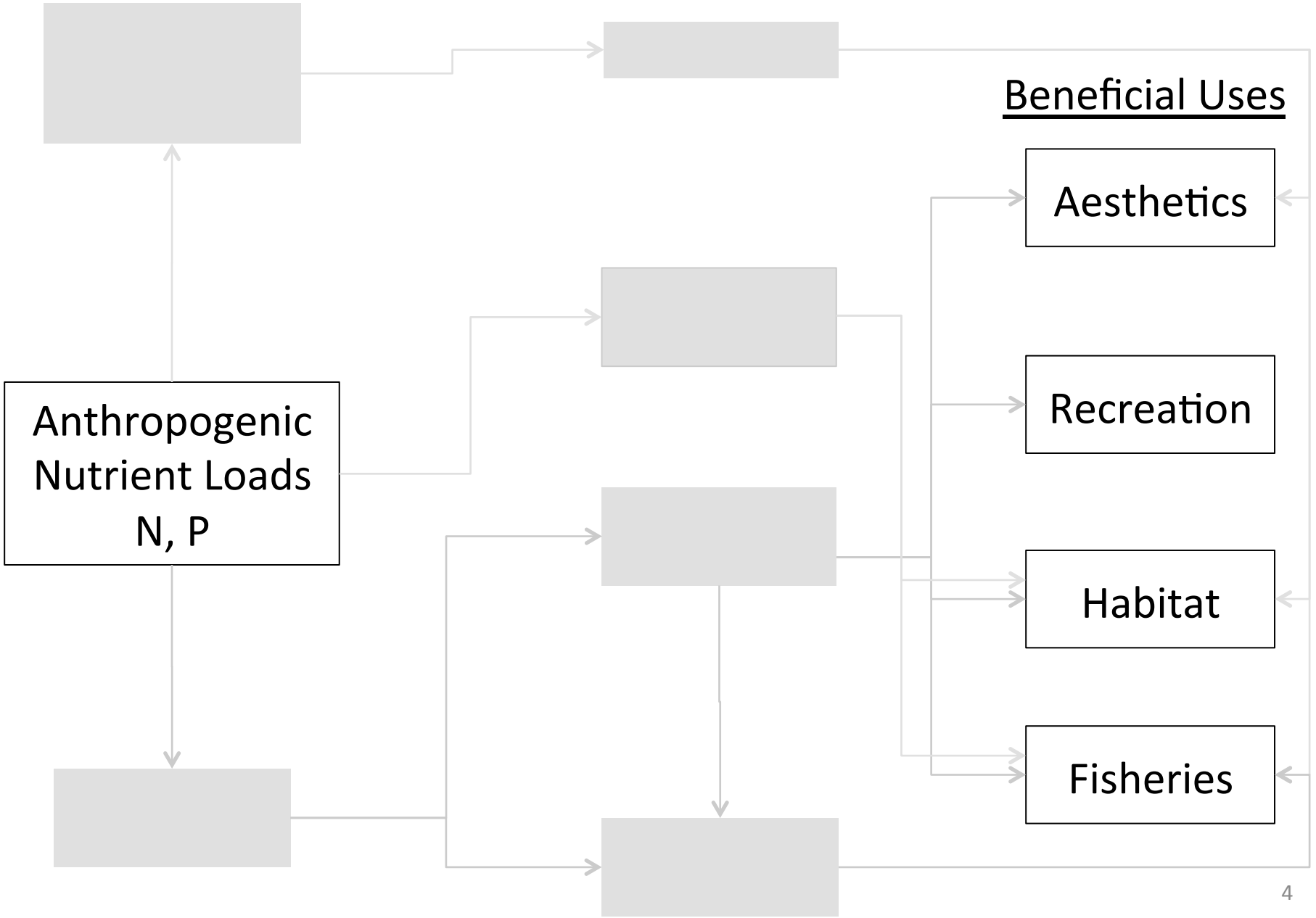


Highest Priority Nutrient Issues in SFB

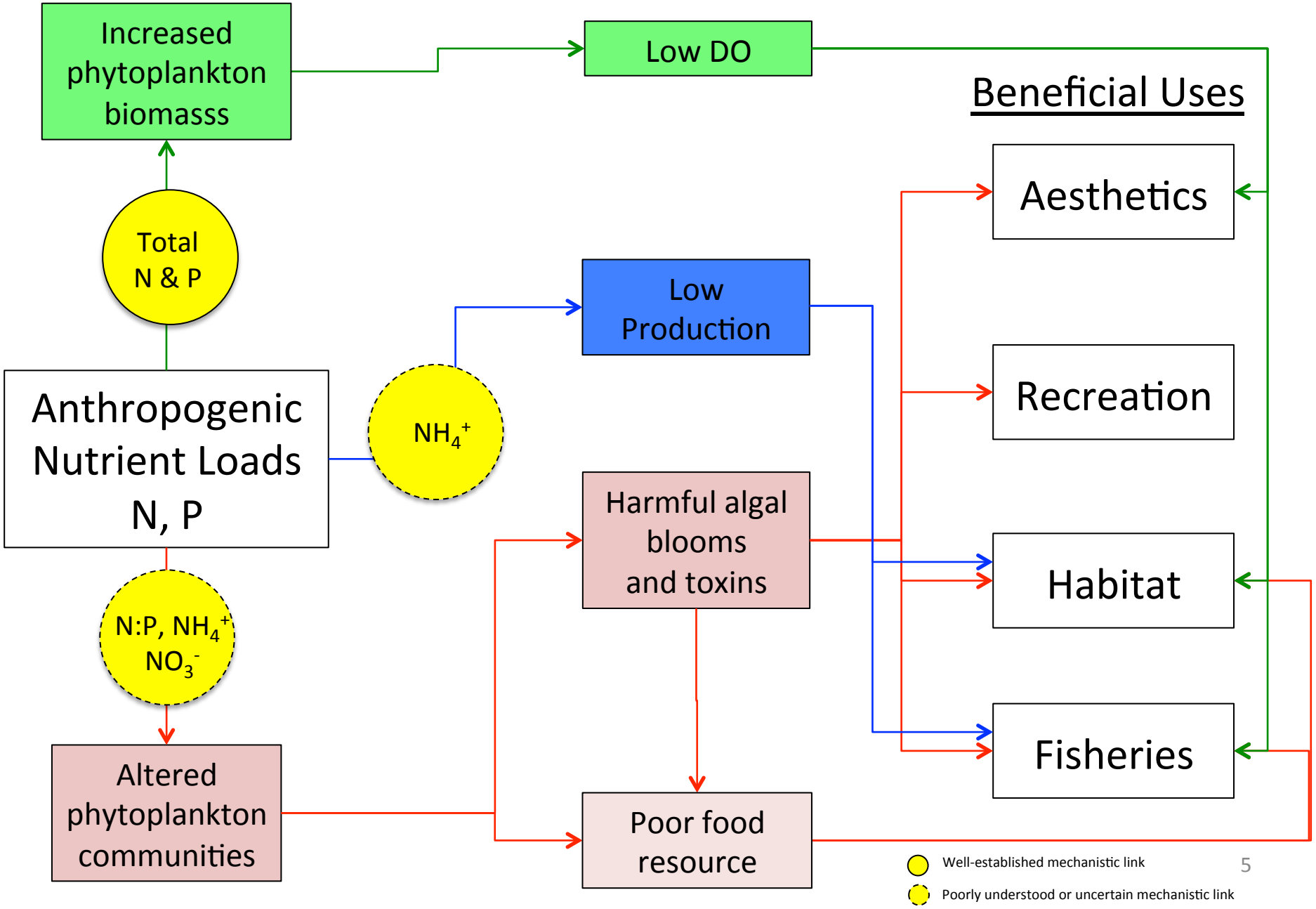
- Determine whether increasing biomass signals future impairment
- Quantify factors that adversely affect phytoplankton composition, including the potential for Harmful Algal Blooms and toxins
- Determine if low DO in shallow habitats causes impairment
  - Quantify role of nutrients
- Test future scenarios that may lead to worsening conditions
- Quantify nutrient contributions to different areas of the Bay
- Test mitigation/prevention scenarios

SFEI 2014b

Potential Pathways to Adverse Impacts



Potential Pathways to Adverse Impacts



2011-2014

Past Studies or Studies Underway

External Loads Study

Effluent Characterization

Effluent Characterization

Delta Loads

Hydrodynamic and Water Quality Modeling

NNE Report

Nutrient Strategy

Conceptual Model

Suisun Synthesis I

Science Plan

LSB Synthesis

Suisun Synthesis II

Assessment Framework Planning

Evaluate Assessment approaches

HAB Toxins

On-going monitoring

Suisun Field Studies

Suisun Field Studies

Pilot: Phyto pigments

Pilot: Moored Sensors

Data Analysis/ Interpretation

Program Design/ Development

On-going monitoring

Suisun phyto studies

Quantify Loads

Load Reductions: Scenarios

Modeling

Synthesis, Science Plan

Assessment Framework

Monitoring, Special Studies

Key Background Documents (and recommendations)

- Nutrient Strategy

http://www.waterboards.ca.gov/sanfranciscobay/water_issues/programs/planningtmdls/amendments/estuarineNNE/Nutrient_Strategy%20November%202012.pdf

- Scientific Foundation for a San Francisco Bay Nutrient Strategy (aka, Conceptual Model Report)

SFEI 2014a

Draft. Final in May 2014

http://www.waterboards.ca.gov/sanfranciscobay/water_issues/programs/planningtmdls/amendments/estuarineNNE/SAG-June-2013/Nutrients_CM_DRAFT_May12013.pdf

- Suisun Bay Ammonium Synthesis

http://www.sfei.org/sites/default/files/SuisunSynthesisI_Final_March2014_0.pdf

- External Nutrient Loads to San Francisco Bay

SFEI 2014b

http://www.sfei.org/sites/default/files/NutrientLoadsFINAL_FINAL_Jan232014_0.pdf

- Approaches to a Nutrient Assessment Framework

SCCWRP 2013

http://www.waterboards.ca.gov/sanfranciscobay/water_issues/programs/planningtmdls/amendments/estuarineNNE/SAG-June-2013/NNE_Framework_White_Paper.pdf

- Characterizing Nutrient Trends, Loads, and Transformations in Suisun Bay and the Delta.

SFEI 2014d

http://www.sfei.org/sites/default/files/IEP%202014%20ENovick%20FINAL.pdf

- Model Development Plan

http://www.sfei.org/sites/default/files/Nutrient_Modeling_Approach_draftFINAL_Jan212014.pdf

- Numeric nutrient endpoint development for San Francisco Bay – Lit review and data gaps analysis

http://www.sfei.org/sites/default/files/644_SFBayNNE_LitReview%20Final.pdf

- Approaches to a Nutrient Assessment Framework, Draft

http://www.waterboards.ca.gov/sanfranciscobay/water_issues/programs/planningtmdls/amendments/estuarineNNE/SAG-June-2013/NNE_Framework_White_Paper.pdf

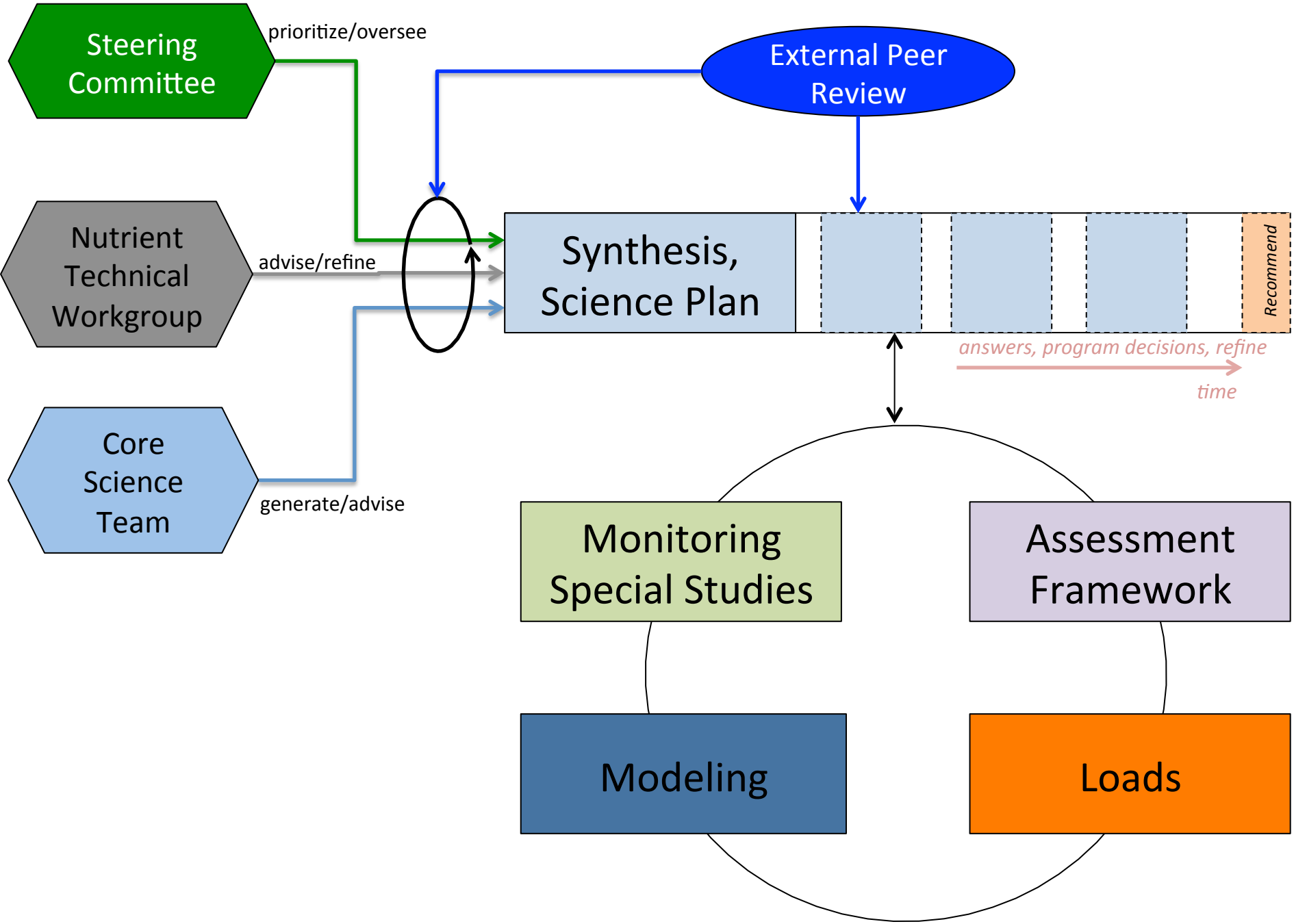
Available Funding for FY2015

Program	Amount	Notes
new		
Nutrient Steering Committee	~$800	
RMP*	$500	moored sensors, modeling
SFB Water Board	$65k	Science Plan Development
SFB Water Board	$100k	Dissolved oxygen objectives
Carry forward		
RMP Modeling	~$300k	From prior years
total	$1.8mill	

*Provisionally allocated

Science Plan

- The science plan will be developed over the coming year and will serve as a guide, prioritization, and workflow/schedule for major activities needed inform nutrient management decisions in SFB.
- Over the past two years, we've been identifying and prioritizing projects based on recommendations from the draft Conceptual Model Report, and recruiting input from technical advisors and stakeholders
- For the FY2015 proposed projects, while developing the longer term (5yr) Science Plan, we are following a similar approach, and ensuring that the proposed projects are "no regrets" studies that will ultimately be part of the Science Plan, and ones that would implemented in its early phases.
- It is expected that the Science Plan will be consistent with the broad recommendations laid out in the Nutrient Strategy. The Science Plan will, however, go into substantially more detail in terms of specific study and data needs, a proposed workflow schedule, and estimated costs. In large part, the Science Plan will actually integrate across recommendations laid out for the major Nutrient Science Program components…monitoring, modeling, special studies, assessment framework.
- While the Science Plan is not yet developed, several of the key reports whose recommendations will inform much of the Science Plan are complete or in draft form. Recommendations for FY2015 are based on recommendations or priorities identified in:
  - Conceptual Model Report
  - Suisun Synthesis I
  - Monitoring Program Development Plan
  - Modeling Plan
  - Assessment framework plan
- Relevant excerpts from those reports are included at the end of this document. The full Monitoring Program Development Plan is also included.


Steering Committee
prioritize/oversee
External Peer Review
Nutrient Technical Workgroup
advise/refine
Synthesis, Science Plan
Recommend
answers, program decisions, refine
time
Core Science Team
generate/advise
Monitoring Special Studies
Assessment Framework
Modeling
Loads

Sediment Quality Assessment of San Francisco Bay Site on the 303(d) List: Pacific Dry Dock, Oakland, Calif.

Estimated Cost: $45,000

Oversight Group: RMP Exposure and Effects Workgroup (EEWG)

Proposed by: Ellen Willis-Norton, Karen Taberski, and Phil Trowbridge

Date: May 12th, 2014

Proposed Deliverables and Time Line

Deliverable	Due Date
Task 1: Project management	Throughout 2015 – Finalize study design, write and manage subcontracts, track budgets
Task 2: Sample collection and data analysis	June- July 2015
Task 3: Reporting	Draft Memorandum– March 2016 Final Memorandum– June 2016

Background and Justification

In August 2009, the State Water Resources Control Board (State Water Board) adopted the Sediment Quality Objectives for Enclosed Bays and Estuaries. These sediment assessment methods use the sediment triad approach to evaluate the ecological condition of sediments from a site, using measurements of sediment chemistry, toxicity tests, and benthic community condition (Bay *et al.*, 2009). The San Francisco Bay Regional Water Quality Control Board (Water Board) is interested in employing these SQO assessment methods to evaluate sediment condition at the Pacific Dry Dock and Repair Yards 1 and 2, Oakland, Calif., a site on the 303(d) list[1].

The proposed study will conduct Sediment Quality Objectives assessments (SQOs) at three locations within the Pacific Dry Dock site to support the Water Board's management decisions. The Pacific Dry Dock is located within the geographic region of the Estuary currently defined as the polyhaline benthic assemblage by the current SQO guidance documentation – between the Dumbarton Bridge in the south and the Richmond Bridge in the north (Bay *et al.* 2009).

This study will address RMP management questions (listed below) related to pollutant effects on benthic organisms including: evaluating the long-term persistence of benthic impacts at contaminated sites, and the utility of the SQO approach in evaluating sediment

[1] http://www.waterboards.ca.gov/water_issues/programs/tmdl/2010state_ir_reports/category5_report.shtml

condition. This study will provide the Water Board with SQO assessments of an important estuary margin site of concern in the Central Bay region of the San Francisco Estuary in support of managing contaminated sites and 303(d) listing decisions.

Study Plan

This study will limit its focus to a site that falls within the polyhaline benthic assemblage as defined by the current SQO guidance (Bay *et al.,* 2009). Benthos samples will be further evaluated to confirm they are placed in the right benthic assemblage using salinity measures and indicator taxa defined in the SQO guidance documentation. If samples do not fall within the expected polyhaline assemblage, alternative benthic assessments may be used to provide a basis for comparison of condition. The RMP and SCCWRP are currently working on revising and formalizing the mesohaline SQO benthic assessment methods and these new methods may be used to evaluate benthic community condition in samples if the resulting samples are determined to belong to the mesohaline assemblage.

This study will consist of three tasks:

1. Project management:
This task includes study design, logistics, and coordination among sample collection and laboratories. Three samples will be collected under the current budget, and the full suite of triad measures previously monitored as part of RMP Status and Trends will be analyzed. Sample locations will be selected after detailed review of previous sediment studies performed on behalf of Crowley Maritime Corporation, the current owners of the site, following remediation efforts. Re-assessing previously characterized locations will provide specific comparisons needed to determine if sediment condition has improved. Contracts for boat rental and laboratory analyses will be required.

2. Sample collection and analyses:
Previous experience collecting sediment samples along Bay margins indicates successful sampling will require use of a dedicated boat for a single day; attempts to collect margin sediment samples in conjunction with a Baywide sediment cruise are not often effective given the shallow margin waters and tidal constraints.

The same analytical laboratories and core analyte list as monitored by previous RMP Status and Trends sediment monitoring efforts will be used in this study in order to maximize the use of the data in other RMP studies (Willis-Norton *et al.* 2013).

Surface sediment will be sampled and analyzed for the full suite of RMP Status and Trends measures including:

- Sediment and water quality - grain-size, TOC, TN, and a CTD cast will be taken to record water quality conditions near the bottom.
- Trace metals
- Trace organics
- Toxicity to two test species (*Eohaustorius estuarius* and *Mytilus galloprovincialis*)
- Benthic macrofauna

3. Reporting:
Sediment assessment scores will be compared among locations and to existing RMP Status and Trends program scores (Willis-Norton *et al.* 2013). The Status and Trends program conducted SQO assessments from 2008 to 2012 at a subset of the long-term sediment monitoring sites (sampled annually on an alternating wet and dry season sampling period). Those sites are located throughout the Estuary and represent ambient conditions as they are not located near known sources of pollution. Comparing the study location scores to those in the Estuary will provide perspective about the respective ecological condition of sediments in the Estuary as a whole and in the Estuary margins - near pollution sources.

Applicable RMP Management Questions

EEWG benthic effects management questions:

1. What are the spatial and temporal patterns of impacts of sediment contamination on benthic biota?

   The proposed study will employ the SQO methods for Enclosed Bays and Estuaries to assess ecological condition, and if there is a potential concern of degraded conditions due to pollution. This Study will focus on an impaired site located in the Estuary margins and SQO assessment scores will be compared to the RMP Status and Trends scores from the ambient survey design. To evaluate temporal patterns, locations that were sampled previously may be re-assessed to investigate to what extent sediment condition has improved.

2. Are the toxicity tests, benthic community assessment approaches, and the overall SQO assessment framework we are using reliable indicators of impacts on benthic biota?

   The SQO methods for Enclosed Bays and Estuaries will be implemented to investigate sediment condition at a site considered impaired prior to a remediation effort, informing us regarding how sensitive these tools are and if they can detect changes in sediment condition over time or after remediation efforts have been completed.

Budget Estimate

Description	Cost Estimate ($)
Sediment Chemistry	**9,400**
Sediment Toxicity (Eohaustorius & Mytilus)	**6,000**
Benthos	**6,600**
Management, Sampling and Reporting	**17,000**
Other Expenses	**6,000**
Logistics contract, vessels, shipping, travel, etc.	
Total Cost Estimate	**$ 45,000**

References

Bay S., D.J. Greenstein, J.A. Ranashinghe, D.W. Diehl, A.E. Fetscher. 2009. Sediment Quality Assessment Draft Technical Support Manual. Technical Report 582. May, 2009. Southern California Coastal Water Research Project. Costa Mesa, CA.

Hunt, J.W., Anderson, B.S., Phillips, B.M., Newman, J., Tjeerdema, R.S., Taberski, K.M., Wilson, C.J., Stephenson, M., Puckett, H.M., Fairey, R., Oakden, J. 1998. Sediment Quality and Biological Effects in San Francisco Bay. Final Report for the Bay Protection and Toxic Cleanup Program. California State Water Resources Control Board.

Willis-Norton, E., Ranasinghe, J.A., Greenstein, D., Taberski, K., Feger, N. 2013. Applying Sediment Quality Objective Assessment Protocols to Two San Francisco Bay 303(d)-Listed Sites. RMP Contribution 699. August, 2013. San Francisco Estuary Institute, Richmond, CA.

DIOXIN SYNTHESIS REPORT

Donald Yee, Jay Davis, SFEI, Richmond, CA

ESTIMATED COST: $40,000
OVERSIGHT GROUP: Dioxin Strategy Team

Proposed Deliverables And Timeline

Deliverable	Due Date
Task 1. Simple mass budget model	Mar 2015
Task 2. Simple bioaccumulation model	Mar 2015
Task 3. Draft and final report	Sep 2015

Background

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 (commonly referred to as 'dioxin') in fish. RMP studies of contaminants in Bay sport fish conducted every three years since 1994 have found that dioxin concentrations have remained unchanged over this time period and in some species, continue to greatly exceed screening values for human consumption. The available information for dioxin in the region was synthesized in a conceptual model/impairment assessment report in 2004 for the Clean Estuary Partnership. That report highlighted limited data and significant uncertainties and gaps in our understanding of spatial and temporal distributions of dioxin in Bay waters and sediments, and in estimated loading rates via various pathways. Data on dioxin in ambient open bay sediments has been roughly doubled since then, and the number of water locations characterized increased ten-fold. Dioxin in wetland sediment cores has also been characterized, suggesting a drastic decrease from recent (post WWII) past concentrations, whereas open Bay cores show more uniform distributions, with concentrations in upper sections higher than in very deep pre-industrial sediments, but generally similar to current surface sediment concentrations. Additional information on loads from pathways such as atmospheric deposition and stormwater runoff has been collected.

Together this information will be synthesized to update our understanding of environmental distributions and processes of dioxin, with the aim of addressing the priority dioxin management questions (described below) and identifying remaining data needs or gaps/uncertainties.

Applicable RMP Objectives and Management Questions

The work synthesized in the report addresses the following RMP Objectives and Management Questions:

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

- Are the beneficial uses of San Francisco Bay impaired by dioxins?

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

- What is the spatial pattern of dioxin impairment?
- What is the dioxin reservoir in Bay sediments and water?

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

- What is the relative contribution of each loading pathway as a source of dioxin impairment in the Bay?

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

- Have dioxin loadings/concentrations changed over time?

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

- What future impairment is predicted for dioxins in the Bay?

Approach

The available (past and new data collected over the last several years) information will be applied to a simple one-box mass budget model and to a simple bioaccumulation model (both previously applied to PCBs and other organics) to identify and prioritize remaining data gaps and/or conflicts with current conceptual models and expectations, in order to evaluate the needs for and possible designs of future monitoring and modeling efforts.

Reporting

Results of applied models and associated monitoring data in various matrices for the estuary will be reported as a RMP Technical Report, to be delivered in the third quarter of 2015.

Proposed Budget

Estimated costs for each of the elements are presented. Even if data are not applied to numerical mass budget and bioaccumulation models, information will still need to be considered in the context of conceptual models of contaminant processes and fate/ bioaccumulation, so costs for the first two tasks will be reduced (roughly halved), but not eliminated.

Task	**Estimated Cost**
Application of data to mass budget	$10,000
Application of data to bioaccumulation model	$10,000
Draft and final report	$20,000
Total	**$40,000**

1) Selenium in Sturgeon Muscle Plugs

Oversight Group: Selenium Strategy Team
Proposed by: Jay Davis, SFEI

Funding requested for 2014: $23,000

Introduction and Background

In April 2014 the RMP formed a Selenium Strategy Team to evaluate information needs that can be addressed by the Program in the next several years. The charge given to the Team by the RMP Steering Committee was to focus on low-cost, near-term monitoring elements that could provide information that provides high value in support of policy development and decision-making. A TMDL for the North Bay is in development by the Regional Water Board, with a staff report in preparation.

The TMDL will establish a target concentration in white sturgeon muscle tissue as the basis for evaluating impairment. White sturgeon is a bottom-feeding species that is considered to be at substantial risk for selenium exposure in the Bay (Beckon and Mauer 2008). White sturgeon are particularly at risk because their diet consists primarily of the overbite clam (*Potamocorbula amurensis*), which are selenium-rich relative to other prey (Stewart et al. 2004). Other increased risk factors for sturgeon include their longevity (they can live over 100 years), their year-round resident status, and long egg maturation times (several years) (Beckon and Mauer 2008). Green sturgeon are also considered to be vulnerable to selenium but their exposure could be limited. Adults and sub-adults spend a large portion of their lives in coastal marine waters outside of the estuary, and are only briefly exposed to high selenium diet during their infrequent spawning migrations through the Bay. In addition, green sturgeon are a threatened species and fishing for them is prohibited.

White sturgeon have been routinely sampled (in 1997, 2000, 2003, 2006, 2009, and 2014) by the RMP sport fish monitoring element since 1997. However, the number of fish collected in each round of sampling has been small (12 fish per round), and the collections are currently being performed on a five year cycle. The upper end of the distribution of concentrations measured in North Bay sturgeon exceed the target under consideration for the TMDL, but this determination is based on a relatively small number of samples. Identifying a means to obtain a larger number of white sturgeon muscle samples on a more frequent basis has been identified as a high priority by the Selenium Strategy Team, both to obtain a more precise understanding of impairment and to track inter-annual trends.

In the 2009 RMP sport fish sampling, an effort began to establish a nonlethal and efficient method of collecting sturgeon muscle through the use of plugs. Concentrations in plugs were found to correlate well with concentrations in muscle fillets for the 12 fish sampled. Another round of evaluation of this correlation will occur with the 12 sturgeon to be collected in the 2014 sport fish monitoring (note these fish are separate from the fish to be sampled in this proposal). This correlation is opening the door to an opportunity to obtain a larger number of sturgeon muscle samples, non-lethally, through a collaboration with a California Department of

Fish and Wildlife annual tagging program that is tracking population trends (DuBois and Harris 2013; more information at http://www.dfg.ca.gov/delta/data/sturgeon/bibliography.asp).

This proposal is requesting funds to perform collaborative plug sampling in 2014. Performing this work in 2014 may result in the data being incorporated in the TMDL staff report that is currently in preparation.

Study Objective and Applicable RMP Management Questions:

This objective of this study is to obtain a relatively large number of sturgeon muscle samples (30 white sturgeon and, if possible, 10 green sturgeon) both to obtain a more precise understanding of impairment and to begin to track inter-annual trends.

Selenium Strategy questions addressed:

2. Are the beneficial uses of San Francisco Bay impaired by selenium?
4. How do selenium concentrations and loadings change over time?

RMP Management Questions addressed:

1. Are chemical concentrations in the Estuary at levels of potential concern and are associated impacts likely?
   B. What potential for impacts on humans and aquatic life exists due to contaminants in the Estuary ecosystem?
4. Have the concentrations, masses, and associated impacts of contaminants in the Estuary increased or decreased?
   B. What are the effects of management actions on the potential for adverse impacts on humans and aquatic life due to Bay contamination?

Study Approach

The study would be performed in collaboration with CDFW and USGS. SFEI staff would plan the study, train CDFW staff and perform sampling, manage the data, and write a brief technical report. USGS (Robin Stewart and her team) would perform analysis of selenium and stable isotopes of C, N, and S in the plugs. The stable isotopes provide information on diet and habitat use by the sturgeon. The sampling would occur during the course of the CDFW survey in August through October.

Thirty white sturgeon plugs will be collected and analyzed. Another 30 will be collected and archived in case additional samples are needed. Up to ten green sturgeon plugs, if possible, will be collected and analyzed.

Tasks and Budget

- Planning: decide on methods, coordination
  - SFEI: $600 (1 day)
- Training and field work
  - SFEI: $2500 (4 days)
- Sample processing (including archiving)

    - USGS: $500
- Analysis
    - Selenium
        - USGS: $6,600 (40 samples @ $165)
    - Isotopes
        - USGS/UCD: $2,000 (40 samples @ $50)
- Data management and QA
    - SFEI: $7505
- Reporting - short technical report to document methods and results, plot data with past data
    - SFEI: $2500 (4 days)

Total Cost: $23,000 (rounded up from $22,205)

Deliverables and Timeline

Draft technical report	Feb 2015
Final technical report	Mar 2015

References

Beckon, W. and T. Mauer. 2008. Species at Risk from Selenium Exposure in San Francisco Estuary. Final report to the USEPA. US Department of the Interior, Fish and Wildlife Service. http://www.waterboards.ca.gov/sanfranciscobay/water_issues/programs/TMDLs/northsfbayselenium/Species_at_risk_FINAL.pdf

DuBois, J. and M.D. Harris. 2013. 2013 Field Season Summary for the Adult Sturgeon Population Study. http://www.dfg.ca.gov/delta/data/sturgeon/bibliography.asp

Stewart, R.A., S. Luoma, C. Schlekat, M. Doblin, and K. Hieb. 2004. Food web pathway determines how selenium affects aquatic ecosystems: a San Francisco Bay case study. Environ. Sci. Technol. 38. 4519-4526.

2) Correlating Selenium in Sturgeon Muscle Plugs and Eggs

Oversight Group: Selenium Strategy Team
Proposed by: Jay Davis, SFEI

Funding requested for 2015: $20,000

Introduction and Background

In April 2014 the RMP formed a Selenium Strategy Team to evaluate information needs that can be addressed by the Program in the next several years. The charge given to the Team by the RMP Steering Committee was to focus on low-cost, near-term monitoring elements that could provide information that provides high value in support of policy development and decision-making. A TMDL for the North Bay is in development by the Regional Water Board, with a staff report in preparation.

The TMDL will establish a target concentration in white sturgeon muscle tissue as the basis for evaluating impairment. White sturgeon is a bottom-feeding species that is considered to be at substantial risk for selenium exposure in the Bay (Beckon and Mauer 2008). White sturgeon are particularly at risk because their diet consists primarily of the overbite clam (*Potamocorbula amurensis*), which are selenium-rich relative to other prey (Stewart et al. 2004). Other increased risk factors for sturgeon include their longevity (they can live over 100 years), their year-round resident status, and long egg maturation times (several years) (Beckon and Mauer 2008). Green sturgeon are also considered to be vulnerable to selenium but their exposure could be limited. Adults and sub-adults spend a large portion of their lives in coastal marine waters outside of the estuary, and are only briefly exposed to high selenium diet during their infrequent spawning migrations through the Bay. In addition, green sturgeon are threatened species and fishing for them is prohibited.

White sturgeon have been routinely sampled (in 1997, 2000, 2003, 2006, 2009, and 2014) by the RMP sport fish monitoring element since 1997. The tissue analyzed has been muscle fillets. Future monitoring of white sturgeon is anticipated to focus on muscle plugs, as described in the 2014 proposal "Selenium in Sturgeon Muscle Plugs". Sampling of sturgeon eggs, although logistically more challenging, would provide a more direct metric of the risk to sturgeon reproduction. USEPA recently published draft selenium criteria for freshwater that highlight egg or ovary data as a preferred endpoint most directly tied to adverse effects. Data that would allow evaluation of the correlation between muscle concentrations and egg concentrations would enhance the application of muscle plugs as an impairment indicator.

An annual sturgeon fishing tournament in the Delta provides an opportunity to obtain a small number of female sturgeon in 2015. In this Sturgeon Derby, held on Super Bowl weekend, anglers attempt to catch sturgeon that come closest to a selected size. Fish that are close to the target size are brought in to a central location and sacrificed. For the past several years, the USFWS has collected tissues from these sturgeon and analyzed them for a suite of metals and organics, including selenium, in gonads (including ovaries), liver, and plasma. These data have not yet been published. But the USFWS study does not analyze muscle, because the USFWS has

not requested muscle tissue from the anglers. The average number of fish that are sampled in this effort is around 40, with about half being females. Eggs will be targeted in this proposed study if possible, with ovaries as an alternative if eggs can not be sampled. If eggs are collected, stage of egg development will be noted if possible.

This proposal is requesting funds to measure selenium in muscle plugs and eggs or ovaries from the sturgeon Derby in 2015.

Study Objective and Applicable RMP Management Questions:

This objective of this study is to obtain data to evaluate the correlation between muscle and egg or ovary selenium concentrations through a collaboration with USFWS, local fishermen, and USGS.

Selenium Strategy questions addressed:

2. Are the beneficial uses of San Francisco Bay impaired by selenium?

RMP Management Questions addressed:

1. Are chemical concentrations in the Estuary at levels of potential concern and are associated impacts likely?
   B. What potential for impacts on humans and aquatic life exists due to contaminants in the Estuary ecosystem?

Study Approach

The study would be performed in collaboration with USFWS and USGS. SFEI staff would plan the study, perform sampling, manage the data, and write a brief technical report. USGS (Robin Stewart and her team) would perform analysis of selenium and stable isotopes of C, N, and S in the plugs, and of selenium on the eggs or ovaries. The stable isotopes provide information on diet and habitat use by the sturgeon. The sampling would occur on Super Bowl weekend in 2015.

Fifteen white sturgeon muscle plugs will be collected and analyzed. Fifteen splits of their egg or ovary samples will also be obtained from USFWS for analysis by USGS.

Tasks and Budget

- Planning: decide on methods, coordination
  - SFEI: $1260 (2 days)
- Field work
  - SFEI: $2520 (1 person, 4 “days” - the Derby is two days but goes around the clock)
- Sample processing (including archiving)
  - USGS: $200
- Analysis
  - Selenium
    - USGS: $4,950 (30 samples @ $165)
  - Isotopes

        - UCD: $750 (15 samples @ $50)
- Data management and QA
    - SFEI: $7,350
- Reporting - short technical report to document methods and results, plot data with past data, examine correlation among tissues
    - SFEI: $2,625 (4 days)

Total Cost: $20,000 (rounded up from $19,655)

Deliverables and Timeline

Draft technical report	Jul 2015
Final technical report	Aug 2015

References

Beckon, W. and T. Mauer. 2008. Species at Risk from Selenium Exposure in San Francisco Estuary. Final report to the USEPA. US Department of the Interior, Fish and Wildlife Service. http://www.waterboards.ca.gov/sanfranciscobay/water_issues/programs/TMDLs/northsfbayselenium/Species_at_risk_FINAL.pdf

Stewart, R.A., S. Luoma, C. Schlekat, M. Doblin, and K. Hieb. 2004. Food web pathway determines how selenium affects aquatic ecosystems: a San Francisco Bay case study. Environ. Sci. Technol. 38. 4519-4526.

16) Selenium Strategy Coordination and Technical Support

Oversight group: Selenium Strategy Team
Proposed by: Jay Davis, SFEI

Funding requested for 2015: $10,000

Introduction and Background

In April 2014 the RMP formed a Selenium Strategy Team to evaluate information needs that can be addressed by the Program in the next several years. The charge given to the Team by the RMP Steering Committee was to focus on low-cost, near-term monitoring elements that could provide information that provides high value in support of policy development and decision-making. A TMDL for the North Bay is in development by the Regional Water Board, with a staff report in preparation. Development of a TMDL for the South Bay will be considered after the North Bay TMDL is completed. In the longer-term, the need for a greater investment in studies in support of managing selenium in the Bay will be considered.

Study Objective and Applicable RMP Management Questions

The objective of this task is to provide coordination and technical support for continuing development of the Selenium Strategy. This task would therefore address all of the questions articulated in the Strategy.

1. What are appropriate thresholds?
2. Are the beneficial uses of San Francisco Bay impaired by selenium?
3. What is the spatial pattern of selenium impairment?
4. How do selenium concentrations and loadings change over time?
5. What are the mechanisms of uptake from water and sediment to biota?
6. What is the relative contribution of each loading pathway as a source of selenium impairment in the Bay?
7. What future impairment is predicted for selenium in the Bay under different management scenarios?
8. What are the best opportunities for management intervention for the most important contaminant sources, pathways, and processes?

The task would also address many of the overarching RMP management questions.

Tasks for 2015

Funds for this task would enable SFEI to continue to convene the Selenium Strategy Team to allow discussions of plans for the North Bay TMDL and the consideration of a TMDL for South Bay, to develop RMP workplans to support these efforts, and for any small-scale synthesis of information that is needed to support these discussions. Datasets and literature that are relevant to these TMDLs will be compiled so they are readily accessible when they are needed for in-

depth analysis. The plan will include a multi-year schedule of budgets and deliverables aimed at providing a technical foundation for the TMDLs.

Timing and Deliverables: An updated selenium multi-year plan in June 2015. The plan will include a multi-year schedule of budgets and deliverables.

1) Priority Margin Unit Conceptual Model Development

Oversight group: PCB Strategy Team
Proposed by: Jay Davis, SFEI

Funding requested for 2015: $100,000

Introduction and Background

The RMP PCB Strategy Team formulated a PCB Strategy in 2009. The Team recognized that a wealth of new information has been generated since the PCBs TMDL Staff Report (SFBRWQCB 2008) was prepared. The Strategy articulated management questions to guide a long-term program of studies to support reduction of PCB impairment in the Bay. The PCB Team recommended two studies to begin addressing these questions. The first recommended study was to take advantage of an opportunity to piggyback on the final year of the three-year small fish mercury sampling in 2010. The second study recommended was a synthesis and conceptual model update based on the information that had been generated since the writing of the TMDL Staff Report.

The small fish monitoring revealed extremely high concentrations of food web PCBs in several areas on the Bay margins (Greenfield and Allen 2013), and highlighted a need to develop a more detailed conceptual model than the one-box model used as a basis for the TMDL. A model that would support the implementation of actions to reduce loads from small tributaries, a primary focus of the TMDL, would be of particular value. A revised conceptual model was developed that shifted focus from the open Bay to the contaminated areas on the margins where impairment is greatest, where load reductions are being pursued, and where reductions in impairment in response to load reductions would be most apparent (Davis et al. 2013).

The margins appear to be a collection of distinct local food webs that share some general similarities but are largely functionally discrete from each other. Monitoring, forecasting, and management should therefore treat these margin locations as discrete local-scale units. Local-scale actions within a margin unit, or in upstream watersheds, will be needed to reduce exposure within that unit. Better characterization of impairment on the margins through more thorough sampling of sediment and biota would help focus attention on the margin units where the need for action is greatest ("priority margin units"), and will also provide an important performance measure for load reduction actions taken in local watersheds. The Synthesis recommended a focus on assessing the effectiveness of small tributary load reduction actions in priority margin units, and provided an initial foundation for these activities.

The 2014 update of the PCB Strategy calls for a multi-year effort to implement the recommendations of the PCB Synthesis pertaining to identifying margin units that are high priorities for management and monitoring, development of conceptual models and sediment mass balances for margin units downstream of watersheds where management actions will occurand monitoring in these units as a performance measure. A thorough and thoughtful planning effort is warranted given the large expenditures of funding and effort that will be needed to implement management actions to reduce PCB loads from urban stormwater.

The work proposed for 2015 would consist of planning activities to prioritize margin units and select an optimal subset for detailed conceptual evaluation and monitoring. This would be followed by the implementation of monitoring in the one or two units of greatest interest in 2016, in parallel with development of conceptual models and monitoring plans for the other few units of greatest interest.

Study Objective and Applicable RMP Management Questions:

The objective of this study is to develop sensitive monitoring strategies to detect the effectiveness of watershed management actions in reducing PCB impairment in selected priority margin units (PMUs).

PCB Strategy questions addressed:

4. What is the total maximum daily load of PCBs that can be discharged without impairment of beneficial uses?
9. What are the effects of management actions on the potential for adverse impacts on humans and aquatic life due to Bay contamination?

RMP Management Questions addressed:

4. Have the concentrations, masses, and associated impacts of contaminants in the Estuary increased or decreased?
    B. What are the effects of management actions on the potential for adverse impacts on humans and aquatic life due to Bay contamination?

Study Approach

The proposed multi-year effort would include a year of planning activities in 2015 to:

1. prioritize and identify the margin units to focus on,
2. develop conceptual models and sediment mass balances for the one or two highest priority units, and
3. continue planning efforts to develop a multi-year workplan in support of the anticipated update of the TMDL in 2020.

Expected outcomes for the 2015 effort will be the identification and conceptual evaluation of one or two priority margin units that will be selected for monitoring, and the development of a monitoring strategy for these units.

It will be extremely valuable to begin implementation of baseline monitoring of the selected margin units in advance of the management actions. Initiating monitoring of the units will therefore be a priority for activities in 2016-2019. The monitoring will be designed to maximize sensitivity to detecting reduced impairment in the margin units. Identification and evaluation of additional priority margin units will also occur in parallel to the initial monitoring of the first one or two units. After the planning effort is completed, monitoring will continue to establish initial baseline conditions, and then to track improvement in response to management actions.

Tasks for 2015

Task 1: Prioritize margin units and select units for intensive evaluation ($30K)

This work would be done by the PCB Strategy Team with staff support from SFEI. An initial survey and prioritization of all the margin units will be conducted. Properties of the margin units to be evaluated will be determined through Team discussion. Data gathering and analysis will be needed to support the prioritization effort, including evaluation of data on contamination in the watersheds and in the Bay, mapping information to link watersheds with margin units, and mapping to delineate boundaries of margin units. All margin units will be considered in this prioritization phase, not just those for which data are already available. It is anticipated that task 1 will require two to three meetings of the PCB Strategy Team.

Timing and Deliverables: Some planning and data compilation will begin in 2014. Data analysis will begin in January 2015. A brief report on the prioritization effort will be drafted by March 2015.

Task 2: Develop conceptual site models and first order mass balances for the highest priority margin units ($60K)

The one or two highest priority margin units (PMUs) will be evaluated in detail in 2015. The following approach will be applied to each PMU. A relatively large Conceptual Site Model Workgroup (CSMW) will be assembled that includes members of the PCB Strategy Team, along with experts on potential biotic indicators, sediment movement from watersheds to margins to the open Bay, and local conditions. This CSMW will meet two to three times to develop and document conceptual understanding and a monitoring plan for the PMU. While ideally the site model evaluations will conclude that it is possible to detect reduced concentrations in the Bay, it is also possible that the CSMW will conclude that this is not feasible with a realistic effort given the relative magnitude of the reduced loading, the reservoir of PCBs already in the PMU, and environmental variation. Schedules for CSMW activities will be established with input from workgroup members and interested parties.

As conceptual models are developed for these PMUs, consideration will be given to whether a general model or family of models can be developed that could apply to margin units more broadly.

The labor required to conduct tasks 1 and 2 is difficult to estimate because this is a novel effort and the data gathering and analysis to be done will be determined through Strategy Team and CSMW discussions. If funds remain from task 1 after the task is completed, they will be applied to task 2. More detailed budgets will be developed and subject to Strategy Team, TRC, and Steering Committee approval as planning proceeds.

Timing and Deliverables: The goal will be to prepare technical reports documenting conceptual site models and monitoring plans for at least one PMU, and perhaps two PMUs, by December 2015. Whether two PMUs is possible depends on the amount of data gathering and analysis needed to develop a sediment mass balance and conceptual model for PMU #1.

Task 3: Development of multi-year plan in support of the TMDL $10K

Funds for this task would enable SFEI to continue to convene the PCB Strategy Team to allow discussions of plans for the next iteration of the TMDL and RMP activities that can inform the TMDL, and for any small-scale synthesis of information that is needed to support these discussions. The plan will include a multi-year plan schedule of budgets and deliverables aimed at providing a technical foundation for the next iteration of the TMDL. Depending on the outcomes of the site model evaluations, this RMP expenditure for continued Strategy Team discussions may need to be augmented or complemented by other forums for discussing TMDL revision.

Timing and Deliverables: An updated PCB multi-year plan in June 2015. The plan will include a multi-year plan schedule of budgets and deliverables.

Item 5: Changes to S&T **Last Updated: 06/13/2014**

SUMMARY OF PROPOSED RMP S&T MONITORING 2014-2023

Program	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	Comments
Water											
Cu, CN, Se, Ancilliary, MeHg		X		X		X		X		X	22 sites
PCB, PAHs, Pesticides, Toxicity								?		?	Every 8 or 10 years; last conducted in 2013 (2011 for toxicity)
CTR (VOCs, SVOCs, etc)		?									Every 10 years last conducted in 2002. 3 sites.
CECs		?		?		?		?			Frequency after 2014 TBD depending on research priorities
PBDEs											Drop
Sediment											
Anicillary, PAHs, PCBs, Hg, MeHg, Toxicity	X- Dry (no toxicity)				X-Wet				X- Dry		Decrease from 47 to 27 sites
PBDEs	X- Dry				X-Wet						Decrease from 47 to 27 sites. Drop after 2018.
Metals (including Se), pesticides	X- Dry								X- Dry		Decrease from 47 to 27 sites
Benthos									X- Dry		Coupled with chemistry in dry years for SQO. No samples in 2014.
Pyrethroids											Drop for bay; monitor in margins
CECs - NP, PFOS, etc.	X		?		?		?		?		2014 sampling will complement study of PFCs in effluent in 2014. Additional sampling TBD.
Bivalves											
PAHs, PBDEs	X		X		X		X		X		Reduce from 11 to 6 sites. Consider dropping PBDEs when declines are firmly established.
PCBs	X								X		
Se	X		X		X		X		X		To support Se TMDL
CECs	X		?		?		?		?		Frequency after 2014 TBD depending on research priorities
Sport Fish											
Suite of Analytes[1]	X					X					Every 5 yr
Pesticides											Drop
Bird Eggs											
Suite of Analytes[2]		X			X			X			Every 3 yr
Pesticides											Drop
USGS Cruises											
	X	X	X	X	X	X	X	X	X	X	Cloern/ Schoelhammer

[1] Sportfish will be analyzed for the following in 2014: PCBs, PBDEs, Hg, Se, dioxins, and PFCs

[2] Cormorant eggs are analyzed for the following: PCBs, PBDEs, Hg, PFCs, and Se. Tern eggs are analyzed for Hg, PBDEs, and Se.

"X" = Planned sampling event. "?" = Potential sampling event.

RMP 2012 Special Study

Development of Benthic Community Condition Indices – San Francisco Bay

Contract#: 1038

Phase I Progress Report

By:

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Introduction

Benthic community assessment is often used as an indicator of ecosystem condition and has become a central element of regulatory programs such as the California's sediment quality objectives (SQO) for bays and estuaries. Benthos are the indicators of choice for monitoring and assessment for several reasons, including:

- Limited mobility makes them reflective of impacts at the site where they are collected.
- Several animal phyla and classes are sensitive to impacts to their environments and can be used to differentiate certain types of effects.
- Life-histories are short enough that the effects of one-time impacts disappear within a year but long enough to integrate the effects of multiple impacts occurring within seasonal time scales.
- Living in the bottom sediments, benthos have high exposure to common anthropogenic impacts, such as sediment contamination, high sediment organic carbon, and low bottom dissolved oxygen.
- They are important components of aquatic food webs, transferring carbon and nutrients from suspended particulates in the water column to the sediments by filter feeding and serving as forage for bottom-feeding fishes.

For benthic data to be useful in a regulatory context, they must be synthesized into some manner of index that can be interpreted in relation to scientifically valid criteria or thresholds that distinguish "healthy" from "unhealthy" benthic communities. While reducing complex biological data to index values has disadvantages, the resulting indices remove much of the subjectivity associated with ad hoc data interpretation. Such indices also provide a simple means of communicating complex information to managers, tracking trends over time, and correlating benthic responses with stressor data.

To date, benthic indices have been calibrated and validated for two nearshore habitats in California, 1) southern California marine bays, and 2) polyhaline (high salinity) portions of San Francisco Bay. Indices have not yet been developed for other habitats throughout the State due to a lack of sufficient calibration/validation data, compounded by a poorer understanding of benthic community stressor-response relationships in lower salinity or naturally disturbed habitats. The lower salinity portions of estuaries are particularly challenging because they are subject to relatively broad ranges of natural environmental conditions (e.g. salinity, dissolved oxygen, turbidity), which produces and endemic fauna adapted to tolerate environmental (and possibly anthropogenic) stress. These challenges for assessment can, however, be overcome through compilation of robust data sets and careful identification of reference conditions to anchor indices.

With the long-term goal of developing a benthic index for the mesohaline/ North and South Bay portions of San Francisco Bay, the objective of Phase 1 of this study was to provide the

necessary underpinnings for index development: 1.) delineation of the mesohaline/ mid-bay habitats; 2.) assembling all relevant biotic and abiotic data for those habitats into a single database; 3.) establish a definition of reference and severely degraded conditions for the system. The results of this analysis will serve as the foundation for Phase 2 of the study: index development and validation.

Findings from Phase 1

Below, we summarize the findings from each task in Phase 1 and detail how it will support Phase 2 of the project.

Task 1 – Delineation of the Mesohaline Habitat

Goal: Refine the spatial definitions of the mesohaline habitat in San Francisco Bay for use in California's SQO program by accounting for additional data and analyses conducted since the original SQO habitat delineations.

Approach – Original habitat definitions for SQO assessment in San Francisco Bay were based upon a Pacific coast-wide macrobenthic community analysis detailed in Ranasinghe et al. (2012). Thompson et al. (2013) conducted a similar, subsequent analysis focused solely on macrobenthic community assemblages in San Francisco Bay. This newer study incorporated ~3.5X as many samples from the San Francisco Bay estuary as Ranasinghe et al. (2012); refining macrobenthic community assemblage definitions and providing greater spatial resolution in the lower salinity portions of the system. Given these advances, these new assemblage definitions were used as a starting point for refining geographic boundaries for the different macrobenthic communities of the San Francisco Bay estuary to be used in the SQO assessments. These delineations define relatively discrete communities that require different assessment approaches or tools within the SQO framework due to changes in benthic community composition occurring naturally across the estuarine gradient.

Results – Thompson et al. (2013) used a cluster analysis based upon Bray-Curtis dissimilarity values of macrobenthic communities to define 5 different community assemblages for San Francisco Bay that roughly follow a gradient in salinity: polyhaline, mesohaline, oligohaline, tidal freshwater, and a coarse sand assemblage. Note that the spatial extent of these assemblages and habitats, though named after estuarine salinity zones, are not bound by the abiotic salinity definitions traditionally associated with those names (i.e., International Association of Limnology 1958).

The relative fidelity and exclusivity of each taxon in the 5 assemblages was calculated to assess the taxonomic contiguousness of a these assemblages as discrete habitats. Samples dominated by taxa with low fidelity and exclusivity to their assigned Thompson et al. (2013) assemblage were assigned to a more appropriate habitat classification. Samples from the adjusted assemblages were then plotted into a geographic information system using their latitude and longitude to evaluate the spatial contiguousness of these new habitat definitions. There was

good spatial clustering of samples within each assemblage, with the exception of the coarse sand assemblage (Figure 1), so these plots were used to delineate habitat definitions (Table 1). The characteristic taxa of each habitat (i.e., those with high assemblage exclusivity and fidelity) are presented in Appendix A.

Table 1 Macrobenthic community assemblages in the San Francisco Bay estuary used to define habitats for use in California Sediment Quality Objectives, modified from Thompson et al. (2013)

Habitat Name	Definition
Polyhaline	From Golden Gate Bridge to the Richmond San Rafael Bridge in the North and the western shore of the South Bay to San Mateo and the mouth of San Leandro Bay in the South
Mesohaline	The main portions of San Pablo Bay north of the Richmond-San Rafael Bridge; excluding the tributaries and the eastern edges of San Pablo Bay. Additionally, the southeastern parts of the South Bay north of the Dumbarton Bridge
Oligohaline	Northern tributaries of San Pablo Bay through Suisun Bay to the western tip of West Island
Tidal Freshwater	East of the western tip of West Island to the head of tide in the San Joaquin Delta
Course Sand	Various points throughout the entire bay, thought to be scoured by currents

Those samples assigned to the coarse sand assemblage, which despite having a distinct, relatively depauperate benthic community, were spread throughout polyhaline, mesohaline, and oligohaline habitat zones. The unifying characteristics of these samples was and that they were from areas thought to experience hydrodynamic scour, which produces well-sorted coarse sand and gravel environments. The resultant benthic community was characterized by consistent observations of the polychaete *Heteropodarke heteromorpha* (Appendix A).

The mesohaline habitat included two areas separated by the higher salinity polyhaline habitat. The southern mesohaline habitat included shallow portions to the east and south of the Central and South Bay, as well as areas to the south of the Dumbarton Bridge. The northern mesohaline habitat extended from the Richmond-San Rafael Bridge north into San Pablo Bay, excluding areas in northernmost and easternmost San Pablo Bay under the influence of freshwater flow from the tributaries (Table 1; Fig 2). Table 2 details the characteristic taxa associated with this habitat. This geographic area was the focal point of our subsequent work.

Product – A map of the different habitats in the San Francisco Bay estuary and lists of their characteristic macrobenthic taxa.

Table 2. Characteristic taxa of the San Francisco Bay estuary mesohaline habitat. Fidelity is a measure of the frequency of occurance of a taxon in the mesohaline-habitat samples relative to those from across the estuary. Exclusivity is a measure of the percent of a taxon's total estuary-wide abundance that was found within the mesohaline habitat.

TaxonName	Group	Fidelity (%)	Exclusivity (%)	Mean Abundance (# 0.05 m^{-2})
Ampelisca abdita	Arthropoda : Amphipoda	86.1	31.9	303.5
Tubificidae	Annelida : Oligochaeta	77.0	15.7	37.2
Heteromastus spp.	Annelida : Polychaeta	68.9	85.8	14.6
Monocorophium acherusicum	Arthropoda : Amphipoda	63.1	9.2	49.5
Neanthes succinea	Annelida : Polychaeta	62.3	91.7	7.7
Corbula amurensis	Mollusca : Bivalvia	59.0	66.6	243.0
Streblospio benedicti	Annelida : Polychaeta	54.1	95.1	46.2
Nippoleucon hinumensis	Arthropoda : Cumacea	48.4	54.9	30.4
Harmothoe imbricata Cmplx	Annelida : Polychaeta	44.3	37.2	4.7
Synidotea laticauda	Arthropoda : Isopoda	42.6	73.6	2.7
Grandidierella japonica	Arthropoda : Amphipoda	38.5	53.5	16.1
Glycinde picta	Annelida : Polychaeta	38.5	26.6	1.8
Sabaco elongatus	Annelida : Polychaeta	33.6	46.8	5.9
Theora lubrica	Mollusca : Bivalvia	31.1	76.6	5.3
Musculista senhousia	Mollusca : Bivalvia	30.3	40.3	1.7

Figure 1. A map of the San Francisco Bay estuary with samples from the 5 different assemblages described in Thompson et al. (2013)

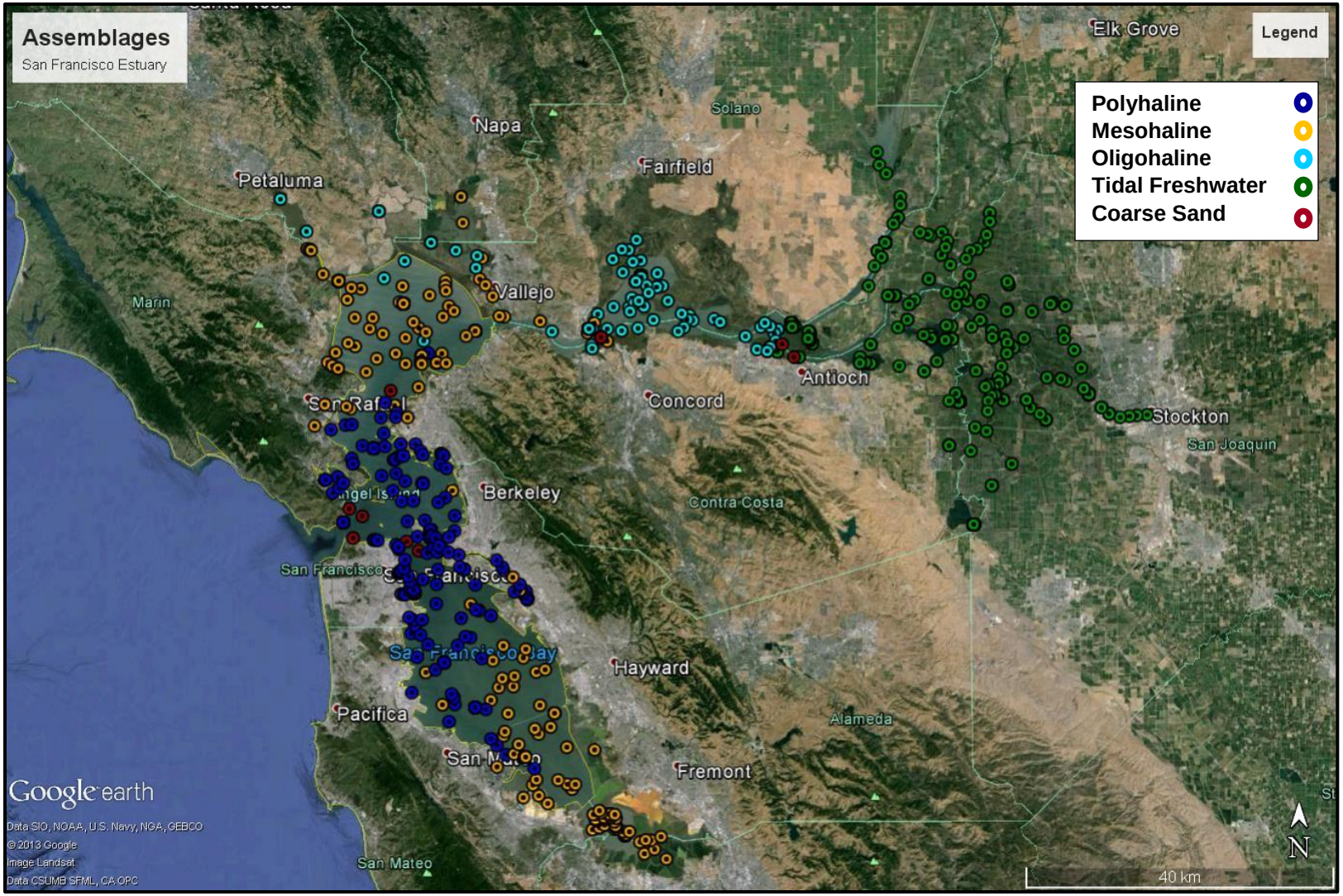
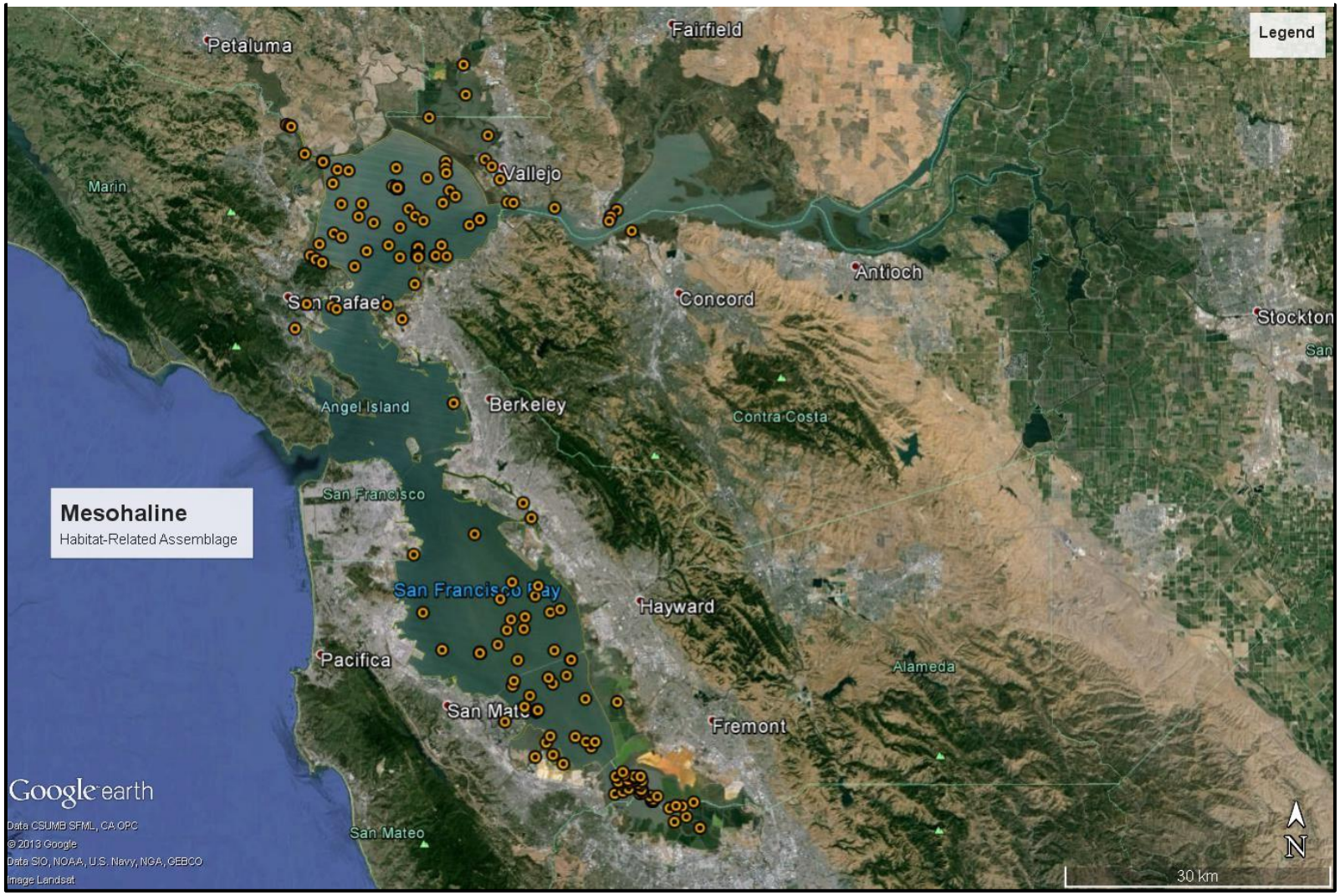


Figure 2. A map of San Francisco Bay estuary highlighting only samples classified as mesohaline in Thompson et al. (2013).



Task 2 – Data Assembly and Standardization

Goal – To assemble all of the available biology, environmental, and stressor data available for the San Francisco Bay estuary that would be used in developing a macrobenthic community assessment tool(s) into a single relational database.

Approach – Macrobenthic abundance and environmental data (e.g., habitat, contaminant, toxicity) from all available San Francisco Bay benthic sampling efforts were aggregated into a single relational database. As these data were from a variety of sampling programs that used different types of sampling gear and taxonomic standards, the data had to be transformed and updated to create a uniform, comparable standard across all samples. Additionally, all samples were assigned to their appropriate new habitat classification so that they could be used in this and future SQO-related work.

Results – Data from 6,857 benthic samples collected during 2,336 sampling events at 486 different sites across all habitat types were compiled. These data came from 11 different sampling programs and were collected from 1992 to 2012 (see database for details). Some combination of depth, sediment composition, or salinity data were available for 2,068 of those sampling events. Sediment contaminant data were available for only 236 sampling events. Sediment toxicity test data, typically amphipod survival tests, were available for 159 sampling events.

Within the mesohaline habitat described under Task 1, data from 1,361 benthic samples from 497 sampling events at 141 different sites. Depth, sediment composition, or salinity data were available for 497 sampling events. Sediment contaminant data were available for 83 sampling events and sediment toxicity data were available for 68 sampling events.

As noted above, these data – from across the entire estuary – were collected by a number of different sampling programs across two decades. Two byproducts of this are that: 1.) different sediment grabs with different surface areas were used; 2.) the taxonomic level (e.g., subclass vs. species for oligochaetes) and taxonomic standards (e.g., *Dorvillea annulata* vs. *Schistomeringos annulata*) varied across years. The largest sediment grab used was a 0.05-m^2 ponar grab, so all abundance data were standardized to # individuals 0.05 m^{-2}. Taxon names were standardized to Southern California Association of Marine Taxonomists species list Edition 6 (SCAMIT 2011).

There were detectable differences in species richness across the different types of gear used for collecting samples, with samples taken with larger gear having more species; a problem not as easily correctable as the abundance differences. However, the differences in species richness among gear types was not uniform along the salinity gradient. The most pronounced effects were in the higher diversity polyhaline habitats, smaller differences in the mesohaline, and no differences among gear types in the oligohaline or tidal freshwater portions of the estuary. As a consequence, care will have to be taken in selection of data for use in the creation of any subsequent assessment index, especially those using species richness/diversity or the presence/absence of rare taxa.

Product – MS Access database of benthic, environmental, and toxicity data

Task 3

Goal – Use expert knowledge of benthic ecology in lower salinity estuarine ecosystems to create definitions of reference and degraded macrobenthic communities that can then be used to develop and validate benthic condition indices for use in SQO assessments.

Approach – A clear definition of reference condition is one the first key steps in developing a habitat assessment tool (Stoddard et al. 2006; Muxika et al. 2007; Hawkins et al. 2010). Understanding reference condition anchors expectations when evaluating novel sites; illustrating how different they are from reference and potentially charting a path towards recovery to that state. There are a variety of ways to set reference expectations for a system (e.g., Hughes et al. 1986; Reynoldson et al. 1997; Ranasinghe et al. 2009), but given the lack of proven conceptual models and the associated difficulty in defining reference conditions in integrative and transitional habitats like estuaries in general, and San Francisco Bay in specific, we chose to develop reference/degraded definitions using the knowledge of experienced benthic ecologists. A panel of nine expert benthic ecologists with experience in lower salinity estuaries and/or San Francisco Bay was assembled to evaluate the condition of macrobenthic community samples. The experts were asked to evaluate the condition of thirty benthic samples from the mesohaline habitat that were selected from along gradients of habitat quality (e.g., sediment contaminants, sediment toxicity, and community parameters).

The expert panel members were given only information on benthic community composition (taxa names and abundance) and environmental characteristics (depth, sediment composition, and salinity) where available. They were not given information on sample location, sediment contaminants, or sediment toxicity. The experts were asked to assign samples into 1 of 4 condition categories – undisturbed through severely degraded – and rank all of the samples from best to worst.

Table 3 Categorical assignments of the condition of macrobenthic samples made by the panel of benthic experts. 1 - Least disturbed; 2 - Low disturbance; 3 - Moderate disturbance; or 4 - Highly disturbed

Sample ID	Expert 1	Expert 2	Expert 3	Expert 4	Expert 5	Expert 6
Mesohaline Sample 1	3	2	2	1	3	2
Mesohaline Sample 2	3	4	3	3	3	3
Mesohaline Sample 3	4	4	3	3	3	3
Mesohaline Sample 4	2	1	3	3	1	3
Mesohaline Sample 5	3	4	1	4	3	3
Mesohaline Sample 6	2	1	1	2	2	3
Mesohaline Sample 7	4	3	3	4	3	3
Mesohaline Sample 8	1	1	1	1	1	1
Mesohaline Sample 9	2	1	3	4	1	3
Mesohaline Sample 10	1	1	1	3	1	2
Mesohaline Sample 11	4	4	1	4	3	3
Mesohaline Sample 12	1	1	1	2	1	2
Mesohaline Sample 13	2	2	3	3	1	3
Mesohaline Sample 14	2	2	1	1	1	2
Mesohaline Sample 15	2	1	1	4	1	3
Mesohaline Sample 16	4	3	1	3	4	3
Mesohaline Sample 17	3	4	2	4	3	4
Mesohaline Sample 18	3	3	3	2	3	3
Mesohaline Sample 19	4	4	1	4	3	4
Mesohaline Sample 20	3	4	3	3	2	4
Mesohaline Sample 21	3	1	2	2	2	2
Mesohaline Sample 22	3	4	3	4	4	3
Mesohaline Sample 23	2	3	1	4	2	3
Mesohaline Sample 24	2	2	3	4	2	3
Mesohaline Sample 25	2	2	1	1	1	3
Mesohaline Sample 26	1	1	1	1	2	1
Mesohaline Sample 27	1	1	1	2	1	2
Mesohaline Sample 28	4	3	3	3	2	3
Mesohaline Sample 29	3	2	1	2	2	3
Mesohaline Sample 30	2	2	3	3	3	3

Table 4. Rank assignments of the relative condition of macrobenthic samples 1 (best) to 30 (worst) made by the panel of benthic experts

Sample ID	Expert 1	Expert 2	Expert 3	Expert 4	Expert 5	Expert 6
Mesohaline Sample 1	24	11	18	4.5	19.5	4.5
Mesohaline Sample 2	21	28	29	18	26.0	23.5
Mesohaline Sample 3	29	26	20.5	16	19.5	23.5
Mesohaline Sample 4	12	10	25	18	5.5	17
Mesohaline Sample 5	16	27	15	26.5	22.0	23.5
Mesohaline Sample 6	10	5	6	6.5	15.0	11.5
Mesohaline Sample 7	28	20	26.5	26.5	22.0	23.5
Mesohaline Sample 8	1	4	11	2	5.5	1.5
Mesohaline Sample 9	6	8	24	29	5.5	11.5
Mesohaline Sample 10	4	1	1	12	5.5	7.5
Mesohaline Sample 11	27	25	14	22	22.0	23.5
Mesohaline Sample 12	5	7	8	9	5.5	4.5
Mesohaline Sample 13	8	15	20.5	13	5.5	11.5
Mesohaline Sample 14	11	12	13	4.5	5.5	7.5
Mesohaline Sample 15	13	6	2	24	5.5	23.5
Mesohaline Sample 16	25	18	10	24	29.5	17
Mesohaline Sample 17	20	29	16	20	28.0	29
Mesohaline Sample 18	22	23	20.5	10.5	26.0	11.5
Mesohaline Sample 19	30	22	5	21	24.0	29
Mesohaline Sample 20	18	24	26.5	18	13.0	29
Mesohaline Sample 21	23	9	17	6.5	17.5	4.5
Mesohaline Sample 22	17	30	29	29	29.5	23.5
Mesohaline Sample 23	15	19	9	24	12.0	17
Mesohaline Sample 24	14	17	24	29	11.0	23.5
Mesohaline Sample 25	9	14	12	3	5.5	11.5
Mesohaline Sample 26	2	3	3	1	17.5	1.5
Mesohaline Sample 27	3	2	4	10.5	5.5	4.5
Mesohaline Sample 28	26	21	29	14.5	15.0	17
Mesohaline Sample 29	19	13	7	8	15.0	17
Mesohaline Sample 30	7	16	20.5	14.5	26.0	11.5

Results – Eight of the nine experts returned evaluations of the samples. However, three of the experts who work together at the same institution consolidated their evaluations together, which resulted in having only 6 sets of sample evaluations to compare.

After the initial evaluation of samples, the experts had relatively good agreement with each other in their assignment of categories (Table 3). One sample was assigned to the same category by all experts, nine were within one category of each other (i.e., 1 or 2, 2 or 3), with an additional 12 samples within or two categories of each (e.g. 1, 2 or 3 and 2 or 3 or 4). There was only a moderate level of agreement in sample ranks among the six experts (Table 4). The average Spearman's correlation coefficient in ranks among the six experts was 0.524, with correlations between individual experts ranging from 0.78 – 0.30 (Table 5). This degree of correlation among results, especially before a formal consensus-building meeting, is good and is equivalent or better than that seen in other similar types of expert opinion exercises (e.g., Weisberg et al. 2008; Teixeira et al. 2010; Ranasinghe et al. 2013).

Table 5. Spearman's correlation coefficients of condition ranks for each the 30 samples (Table 4) evaluated by the benthic expert panel. Comprarisons were made with the experts' rank of a sample to each other, the mean and median rank for a sample, as well as the overall correlation among all of the experts.

	Expert 1	Expert 2	Expert 3	Expert 4	Expert 5	Expert 6
Expert 1		0.697	0.370	0.358	0.651	0.620
Expert 2	0.697		0.594	0.539	0.705	0.779
Expert 3	0.370	0.594		0.376	0.297	0.363
Expert 4	0.358	0.539	0.376		0.311	0.745
Expert 5	0.651	0.705	0.297	0.311		0.453
Expert 6	0.620	0.779	0.363	0.745	0.453	
Correlation w/ Mean Rank	0.807	0.922	0.658	0.639	0.785	0.766
Correlation w/ Median Rank	0.833	0.916	0.632	0.546	0.783	0.694
Mean Correlation w/ Other Expert	0.539	0.663	0.400	0.466	0.483	0.592
Mean Correlation Among all Experts	0.524					

For purposes of defining reference/degraded conditions and validating any future indices, good and bad have been defined as those samples assigned to condition categories 1 and 2 (good) or 3 and 4 (bad) (e.g., Smith et al. 2001; Ranasinghe et al. 2009; Tiexiera et al. 2012). Based on those definitions, the mesohaline dataset evaluated by the experts would have 5-6 good sites and 4-5 bad sites; all with good agreement amongst the experts. Continuing work with the expert panel to build consensus and rectify differences on those samples they nearly agree upon (e.g., all 1's

and 2's, with one 3) will likely increase the number of good and bad validation sites available for future use.

In describing their evaluation process, all of the experts used some combination of abundance, diversity, dominance, and their perceptions of the component taxa's tolerance or sensitivity to disturbance. Experts 2, 3, 4, and 6 focused primarily on whole community metrics like species richness, diversity, and evenness to rank and organize sites; using species composition information to refine their sample order. Conversely, experts 1 and 5 relied more on their perceptions of the tolerance, sensitivity and natural history of the fauna to inform their evaluations, especially the relative abundance of stress sensitive or tolerant taxa in a given sample. This kind of information will be used in helping to craft assessment tools for the mesohaline portions of San Francisco Bay.

Summary

With the completion of Phase I, the ground work to create a robust macrobenthos-based assessment tool for use in California's SQO framework in mesohaline San Francisco Bay is completed. The habitat (i.e., the San Francisco Bay mesohaline community) has been geographically delimited, data for the calibration and validation of an index have been aggregated, and reference/degraded conditions have been defined. The next step in this process will be the development of a tool to assess the condition of the macrobenthic community that is responsive to anthropogenic disturbance and accounts for the natural gradients of mesohaline estuarine systems.

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Appendix B – Characteristic Taxa of Each San Francisco Bay Estuary Habitat

TaxonName	Group	Polyhaline		
		Fidelity (%)	Exclusivity (%)	Mean Abunance (# 0.05 m^{-2})
Tubificidae	Annelida : Oligochaeta	90.8	15.2	33.6
Ampelisca abdita	Arthropoda : Amphipoda	89.3	68.0	602.6
Mediomastus spp.	Annelida : Polychaeta	83.2	98.9	28.4
Dorvillea (*Schistomeringos*) *annulata*	Annelida : Polychaeta	82.4	97.6	11.8
Monocorophium acherusicum	Arthropoda : Amphipoda	74.0	90.8	453.7
Corophium heteroceratum	Arthropoda : Amphipoda	73.3	97.6	99.8
Glycinde picta	Annelida : Polychaeta	72.5	72.3	4.6
Harmothoe imbricata Cmplx	Annelida : Polychaeta	71.8	62.5	7.4
Exogone lourei	Annelida : Polychaeta	71.0	97.6	56.3
Sphaerosyllis californiensis	Annelida : Polychaeta	65.6	96.5	13.9
Euchone limnicola	Annelida : Polychaeta	59.5	97.2	28.6
Leptochelia dubia	Arthropoda : Tanaidacea	58.0	99.2	42.3
Capitella capitata Cmplx	Annelida : Polychaeta	58.0	87.3	4.5
Sabaco elongatus	Annelida : Polychaeta	53.4	53.2	6.2
Nephtys cornuta	Annelida : Polychaeta	51.9	97.2	2.9
Nippoleucon hinumensis	Arthropoda : Cumacea	51.1	36.8	19.0
Eudorella pacifica	Arthropoda : Cumacea	51.1	98.9	25.1
Armandia brevis	Annelida : Polychaeta	48.9	98.5	2.8
Typosyllis spp.	Annelida : Polychaeta	47.3	62.2	5.6
Cirriformia spp.	Annelida : Polychaeta	46.6	89.9	4.3
Amaeana occidentalis	Annelida : Polychaeta	46.6	92.1	2.9
Leitoscoloplos pugettensis	Annelida : Polychaeta	44.3	85.9	1.4
Grandidierella japonica	Arthropoda : Amphipoda	43.5	38.7	10.8
Photis brevipes	Arthropoda : Amphipoda	43.5	100.0	77.4
Glycinde armigera	Annelida : Polychaeta	42.7	77.5	3.0
Monocorophium insidiosum	Arthropoda : Amphipoda	38.9	90.8	30.9
Polydora cornuta	Annelida : Polychaeta	38.9	80.9	4.4
Heteromastus spp.	Annelida : Polychaeta	37.4	11.2	1.8
Caprella californica	Arthropoda : Amphipoda	37.4	89.6	8.3
Molgula manhattensis	Chordata : Ascidiacea	35.9	89.5	12.7
Musculista senhousia	Mollusca : Bivalvia	32.8	59.7	2.3

TaxonName	Group	Mesohaline		
		Fidelity (%)	Exclusivity (%)	Mean Abunance (# 0.05 m^{-2})
Ampelisca abdita	Arthropoda : Amphipoda	86.1	31.9	303.5
Tubificidae	Annelida : Oligochaeta	77.0	15.7	37.2
Heteromastus spp.	Annelida : Polychaeta	68.9	85.8	14.6
Monocorophium acherusicum	Arthropoda : Amphipoda	63.1	9.2	49.5
Neanthes succinea	Annelida : Polychaeta	62.3	91.7	7.7
Corbula amurensis	Mollusca : Bivalvia	59.0	66.6	243.0
Streblospio benedicti	Annelida : Polychaeta	54.1	95.1	46.2
Nippoleucon hinumensis	Arthropoda : Cumacea	48.4	54.9	30.4
Harmothoe imbricata Cmplx	Annelida : Polychaeta	44.3	37.2	4.7
Synidotea laticauda	Arthropoda : Isopoda	42.6	73.6	2.7
Grandidierella japonica	Arthropoda : Amphipoda	38.5	53.5	16.1
Glycinde picta	Annelida : Polychaeta	38.5	26.6	1.8
Sabaco elongatus	Annelida : Polychaeta	33.6	46.8	5.9
Theora lubrica	Mollusca : Bivalvia	31.1	76.6	5.3
Musculista senhousia	Mollusca : Bivalvia	30.3	40.3	1.7

TaxonName	Group	Oligohaline		
		Fidelity (%)	Exclusivity (%)	Mean Abunance (# 0.05 m^{-2})
Corbula amurensis	Mollusca : Bivalvia	86.1	32.7	184.1
Marenzelleria viridis	Annelida : Polychaeta	74.7	97.2	14.6
Tubificidae	Annelida : Oligochaeta	57.0	5.4	19.7
Nippoleucon hinumensis	Arthropoda : Cumacea	46.8	5.9	5.1

TaxonName	Group	Tidal Freshwater		
		Fidelity (%)	Exclusivity (%)	Mean Abunance (# 0.05 m^{-2})
Tubificidae	Annelida : Oligochaeta	94.2	63.8	120.1
Corbicula fluminea	Mollusca : Bivalvia	92.9	94.5	33.8
Gammarus daiberi	Arthropoda : Amphipoda	70.8	99.4	60.4
Prostoma graecense	Nemertinea	42.2	98.0	2.5
Manayunkia speciosa	Annelida : Polychaeta	41.6	100.0	70.9
Americorophium stimpsoni	Arthropoda : Amphipoda	40.3	90.4	17.5
Americorophium spinicorne	Arthropoda : Amphipoda	39.0	99.2	74.4
Pisidium compressum	Mollusca : Bivalvia	36.4	100.0	4.1
Laonome spp.	Annelida : Polychaeta	31.2	46.5	3.0
Melanoides tuberculata	Mollusca : Gastropoda	31.2	98.5	2.2

TaxonName	Group	Course Sand		
		Fidelity (%)	Exclusivity (%)	Mean Abunance (# 0.05 m^{-2})
Heteropodarke heteromorpha	Annelida : Polychaeta	60.0	85.8	13.2

Appendix B – Database Details

SF Bay Benthic Data for SFEI.accdb

This database was assembled by Ananda Ranasinghe and David Gillett. Any questions should be directed to David Gillett (davidg@sccwrp.org). It contains data from benthic sampling events from across all habitats in the San Francisco Bay estuary, spanning a time period from 1992 to 2012. Briefly, this database centers around benthic, environmental, or sediment toxicity data collected during unique sampling events. A sampling event is defined as a unique combination of the place (StationID) and time (SampleDate). Replicate samples (SampleNo) may have been taken during a sampling event, depending upon the sampling program.

Below is a brief description of each table in the database. Naming conventions for the tables are as follows: ***data – ….*** tables contain data produced from the sampling efforts; ***ref – …..*** tables provides explanatory information or details about different fields or codes in the data tables; ***station-info*** contains location/date-time information for each sampling event. Clicking on the relationships view of the database will illustrate how the different tables and fields are related to each other. Each field within the tables is annotated to describe the data contained within.

data – amphipod-toxicity-info – The results of sediment toxicity tests for each sampling event. Primary keys for the table are StationID, SampleDate, and SampleNo. The table contains measures of % survival for each sample and if that number indicates significant toxicity, as defined by the SOP for that test. Data are presented based upon the species of amphipod used in the test (*Eohaustorious estuarius* or *Ampelisca abdita*), as well as being combined into a general, amphipod toxicity measure.

data – benthos – The abundance (# 0.05 m^{-2}) of each taxon identified in a sample. Primary keys for the table are StationID, SampleDate, SampleNo, and TaxonName. The samples were collected with different types and size of sampling gear, so all abundances have been standardized to the number per 0.05 m^2.

data – environmental – Measures of the environmental data associated with each macrobenthic sample. Primary keys are StationID, SampleDate, SampleNo, and ParCode. Data in the table include measures of sediment composition, sediment contaminants (individual constituents, as well as, ERL and ERM quotients and sums), TOC, TN, and overlying water quality. Each parameter is represented by 4-digit numerical code. Translations of the code are provided in the ref – parameters table. Empty cells indicates that no valid data were available.

metadata – Comments on individual data records. Primary key is MetaDataID. The metadata table is linked to every data table, which has a field for a MetaDataID on each record.

ref – data sources – A reference table explaining the ProjectCode field: the name of the project the data were originally collected under and the agency associated with that project. Primary keys ares SourceAgency and Project. Project details were not available for every project, so only abbreviations are currently available.

ref – habclass – A reference table explaining each HabClass code associated with each sampling event in the station-info table. Primary key is HabClass. Habitat descriptions and criteria are from Ranasinghe et al. (2012) and Thompson et al. (2013).

ref – parameters – A reference table explaining each 4-digit ParCode from the environmental table. Primary key is ParCode. Units of measure were not available for most of the parameters.

ref- taxa – A reference table with detailed taxonomic information for each TaxonName in the data – benthos table. Primary Key is TaxonName.

station-info – A table of station and sampling event information, including number of replicate samples collected, location, sampling gear, and the source of the data. Primary keys are StationID and SampleDate. The table also contains information about old station IDs and old habitat membership.

PS/SS: Development of Benthic Community Condition Indices for Mesohaline Environments of the San Francisco Bay.
Phase II – Index Creation and Validation

Oversight group: Exposure and Effects workgroup
Proposed by: David Gillett and Eric Stein, SCCWRP

Funding requested for 2014/15: $106,179

Introduction and Background

Benthic community assessment is often used as an indicator of ecosystem condition and has become a central element of regulatory programs such as the California's sediment quality objectives for bays and estuaries. Benthos are the indicators of choice for monitoring and assessment for several reasons, including:

- Limited mobility makes them indicative of impacts at the site where they are collected.
- Several animal phyla and classes are sensitive to impacts to their environments and can be used to differentiate certain types of effects.
- Life-histories are short enough that the effects of one-time impacts disappear within a year but long enough to integrate the effects of multiple impacts occurring within seasonal time scales.
- Living in the bottom sediments, benthos have high exposure to common anthropogenic impacts, such as sediment contamination, high sediment organic carbon, and low bottom dissolved oxygen.
- They are important components of aquatic food webs, transferring carbon and nutrients from suspended particulates in the water column to the sediments by filter feeding and serving as forage for bottom-feeding fishes.

For benthic data to be useful in a regulatory context, they must be interpreted in relation to scientifically valid criteria or thresholds that distinguish "healthy" from "unhealthy" benthic communities. While reducing complex biological data to index values has disadvantages, the resulting indices remove much of the subjectivity associated with data interpretation. Such indices also provide a simple means of communicating complex information to managers, tracking trends over time, and correlating benthic responses with stressor data.

To date, benthic indices have been calibrated and validated for two nearshore habitats in California, 1) southern California marine bays, and 2) polyhaline (high salinity) portions of San Francisco Bay. Indices have not been developed for other habitats such as the low salinity mesohaline and tidal freshwater environments. These habitats are particularly challenging because they are naturally subject to relatively broad ranges of conditions (e.g. salinity and dissolved oxygen) and hence the resident organisms are adapted to tolerate environmental stress.

The development of any successful assessment tool requires: 1) the clear delineation of the habitat where it will be applied; 2) compilation of available benthic biotic and abiotic data; and 3) the identification of reference conditions to anchor the tool. Phase I of this work (Gillett et al. 2014) details the results of these activities. The work done to date provides the necessary information for the creation, calibration, and validation of an assessment tool(s) for the mesohaline habitats of San Francisco Bay.

However, during discussion of the Phase I results with the RMP advisory committee and interested stakeholders, concerns were raised about the complexity and heterogeneity of the mesohaline portions of the San Francisco Bay Estuary. In light of these concerns, the RMP advisory committee has suggested to first address only the South Bay sub-habitat of the mesohaline San Francisco Bay. Upon successful demonstration of an assessment tool that works in this sub-habitat, its applicability to the other mesohaline habitats can be investigated as well.

As such, the objective of this project will be to develop and calibrate an assessment tool for the evaluation of benthic habitat condition in the mesohaline South Bay sub-habitat of the San Francisco Bay Estuary. The assessment tool will focus on macrobenthic community structure and consist of one or more indices calibrated and validated for the macrobenthic fauna in the southeast portions of South San Francisco Bay, excluding the lower salinity tributaries in the east and south.

Study Objective and Applicable RMP Management Questions:

The objective of this effort is to develop an assessment tool for the mesohaline portions of the South Bay sub-habitat. This work will assist in our ability to answer the following priority questions for the benthos:

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

Study Approach

Reference Definition - As noted above, the Phase I portion of this work began the development of a reference condition definition for the entire mesohaline habitat of the San Francisco Bay Estuary. Given the change in focus of the study to only the South Bay sub-habitat, additional refinement of this reference condition definition will be needed. The new, geographically conscribed area may have, as some of the RMP stakeholders suggest, subtly different reference expectations than the mesohaline habitat considered as a whole. As such, verification of the general mesohaline reference definition in the South Bay sub-habitat will be required. If ecologically meaningful differences in expected community structure are identified, then a new reference definition will be developed in conjunction with the best professional judgement (BPJ) panel assembled for Phase I of this study.

Index Creation and Calibration – Once a suitable reference definition is established for the South Bay, then an assessment tool will be developed to detect statistical and ecological departures from the reference expectation. There are a variety of technical approaches that can be used to measure these departures ranging from a tolerance-to-pollution approach (e.g., BRI [Smith et al. 2001], M-

AMBI [Muxika et al. 2007]) to an environmentally modeled expectation (e.g., RIVPACS [Wright et al. 1993], CSCI [Mazor et al. *in press*]). The final approach used in the assessment tool will be in part technical and in part what is most easily implemented in the RMP. The final assessment tool may consist of multiple indices, as Ranasinghe et al. (2009) have demonstrated that the redundancy of multiple indices can be useful in minimizing the occurrence of false-negatives in multi-stressor environments like estuaries.

Index Validation – First, each calibrated benthic index will be tested for independence from habitat variables such as salinity, sediment grain size distribution, sample depth, latitude, longitude, and total organic carbon. This process is necessary to ensure that the index performance is driven by community condition, not natural habitat factors. Secondly, each index will be tested against an independent set of samples with apriori designations of condition derived from the BPJ panel. This process ensures that the index correctly identifies the condition of novel data. Thirdly, the indices will be evaluated against known gradients of anthropogenic disturbance in the South Bay sub-habitat to ensure responsiveness to stressors observed in the habitat of application.

Index Applicability – Following successful validation in the South Bay sub-habitat, the assessment tool will be applied in other mesohaline habitats of the San Francisco Bay Estuary. If successful, a recommendation may be made to the RMP advisory panel to broaden the geographical application of this tool. If not, the approach used in developing this tool may provide insight into eventual development of an assessment tool for other habitats and sub-habitats of the estuary.

Tasks

Task 1 – Refine and verify reference condition for the South Bay
Task 2 – Create and calibrate indices for use in the assessment tool
Task 3 – Validate index independence, accuracy, and precision
Task 4 – Investigate assessment tool applicability to other mesohaline habitats in the estuary
Task 5 – Prepare final report on index development (Phase I and II) and peer reviewed journal article

Budget, Schedule, and Deliverables

The main products of Phase II would be a validated benthic assessment tool for the South Bay sub-habitat of the San Francisco Bay Estuary, as well as a report and journal manuscripts that document the development and testing process.

The total cost to complete the Phase II tasks would be $106,179 (Table 2**).** With a targeted delivery date of June 30th, 2015.

Table 2. Phase II Budget

Task	Description		Total
1	Refine and Verify Reference Condition	$	18,072
2	Create and Calibrate indices	$	27,521
3	Validate index	$	14,677
4	Index applicability	$	11,009
5	Final Report & Journal Article	$	34,900
	Total	$	106,179

Literature Cited

Gillett, D.J., Ranasinghe, J.A., and Stein, E.D. 2014. Development of Benthic Community Indices – San Francisco Bay. Phase I Progress Report. 19pp.

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Muxika, I., Borja, A., and Bald, J. 2007. Using historical data, expert judgement and multivariate analysis in assessing reference conditions and benthic ecological status, according to the European Water Framework Directive. Marine Pollution Bulletin 55, 16-29.

Ranasinghe, J.A., Weisberg, S.B., Smith, R.W., Montagne, D.E., Thompson, B., Oakden, J.M., Huff, D.D., Cadien, D.B., Velarde, R.G., Ritter, K.J., 2009. Calibration and evaluation of five indicators of benthic community condition in two California bay and estuary habitats. Marine Pollution Bulletin 59, 5-13.

Smith, R.W., Bergen, M., Weisberg, S.B., Cadien, D.B., Dalkey, A., Montagne, D.E., Stull, J.K., Velarde, R.G., 2001. Benthic response index for assessing infaunal communities on the southern California mainland shelf. Ecological Applications 11, 1073-1087.

Wright, J.F., Furse, M.T., Armitage, P.D., 1993. RIVPACS: a technique for evaluating the biological water quality of rivers in the UK. European Water Pollution Control 3, 15-25.

Workgroup Activities – Second Quarter 2014

A. Contaminant Fate Workgroup

Purpose of Workgroup
The purpose of the workgroup is to evaluate the fate of contaminants in the Bay, to understand the contribution of Bay margins to the overall health of the Bay, and to assess the potential impacts of Bay management actions on Bay recovery.

Meetings:
The Contaminant Fate workgroup did not meet in 2013 and will likely not meet in 2014. Advisers will be tapped on an as needed basis for review of related documents and strategies.

Activities for the Third Quarter of 2014:

- Finishing the modeling plan.
- Completing a draft coring manuscript which has been circulated for review by authors.

For more information, see previous CFWG minutes and agendas at our website http://www.sfei.org/rmp/cfwg or contact the CFWG leader, Don Yee, at don@sfei.org.

B. Sources Pathways and Loading Workgroup (SPLWG)/Small Tributaries Loading Strategy Work Group (STLS)

Purpose of Workgroup
The purpose of the workgroup is to monitor storm water, small tributaries, and Delta outflow to understand contaminant loads to the Bay, to identify high priority tributaries for management actions, to evaluate how loads are changing over time, and to assess possible options for improving water quality.

Meetings:

- The STLS group continues to hold monthly phone conferences to planning for Water Year 2015 POC monitoring. Meetings were held on April 1st, April 16th, May 15th, and June 10th.
- The annual SPLWG meeting was held on May 29.

Milestones:

Began preparations for developing a monitoring design and site list for water year 2015 POC monitoring.

Activities for the Third Quarter of 2014:

- Continue preparation for water year 2015 POC monitoring
- Develop workplan for 2014 RWSM

For more information, see SPLWG minutes and agenda at our website http://www.sfei.org/rmp/splwg or contact the SPLWG lead, Lester McKee, at Lester@sfei.org.

C. Exposure and Effects Workgroup

Purpose of Workgroup
The Exposure and Effect workgroup (EEWG) seeks to answer the following questions: Are pollutants individually or in combination having adverse impacts on Bay biota?; Are there spatial and temporal trends?; Which pollutants are responsible for the impacts?; Are there cost-effective tools that can be used to easily monitor these impacts?; and What are the appropriate guidelines?

Meetings:

- The EEWG held a conference call on May 15th, 2014. During the meeting, special studies for 2015 were recommended.

Milestones:

- Completion of a draft of the Mesohaline Index Development San Francisco Bay Index Report Phase I. Report is currently being reviewed by the workgroup.
- Completion of the Bioanalytical Year 1 Progress report (was sent to workgroup for comment). Final report for Year 1 activities has been submitted and will be sent out to workgroup shortly.

Activities for the Third Quarter of 2014:

- Continuation of work on Bioanalytical Tools study (Year 2).
- Copper and olfactory nerve project. The study originally planned on collecting olfactory data from juvenile Chinook salmon late summer 2013 (both before and after smolting in estuarine water). A shutdown of the salmon aquaculture facility at the Mukilteo Research Station earlier this year prevented the study from being able to use Chinook salmon. Coho salmon reared at the Montlake facility in Seattle are available for the study. However, switching to coho salmon requires that smolting occur in the Spring of 2014. This is when the experiment will now take place. No additional funds are needed. NOAA researchers are approximately half-way through collecting data on freshwater coho and will begin the sea-water treatment shortly.

For more information, see previous EEWG minutes and agenda at our website http://www.sfei.org/rmp/eewg or contact the EEWG lead, Meg Sedlak, at meg@sfei.org.

D. Emerging Contaminants Workgroup

Purpose of Workgroup
The purpose of the Emerging Contaminant Workgroup is to identify contaminants of emerging concern (CECs) that have the potential to adversely impact beneficial uses of the Bay.

Meetings:

- The ECWG met April 15th, 2014. During the meeting special studies for 2015 were recommended. Updates were given on the Bioanalytical Tool study, the PFOS precursor study results, alternative flame retardant work, and current use pesticide mapping exercise.

Milestones:

- Finished the Draft PBDE manuscript and will circulate for review among ECWG, TRC and SC.
- Collection of alternative flame retardant effluent and seal samples.
- Completion of the current use mapping pesticide exercise; presentation to TRC and ECWG.
- Completion of the draft pharmaceuticals and personal care products report (out for comment).
- Preparation of a CEC table for the State Panel describing RMP activities in relation to State Panel's recommendation for monitoring estuaries.
- Preparation of proposals for June TRC meeting.

Activities for the Third Quarter of 2014:

- Continuation of NIST broadscan work. Harbor seals manuscript in preparation. Mussel report received and sent to workgroup for comments
- Preparing for the collection of sediment samples for alt. flame retardants.

For more information, see previous EC workgroup minutes and agenda at our website http://www.sfei.org/rmp/ecwg or contact the ECWG lead, Meg Sedlak meg@sfei.org.

E. Nutrients

Purpose of Workgroup
The purpose of this workgroup is to evaluate nutrients status and trends, methods for monitoring nutrients/ indicators, and scenarios that may result in adverse impacts to the Bay. A governance structure for the broader nutrient effort is currently being implemented. RMP is being represented in this broader oversight group, but the RMP also contributes to the nutrient strategy

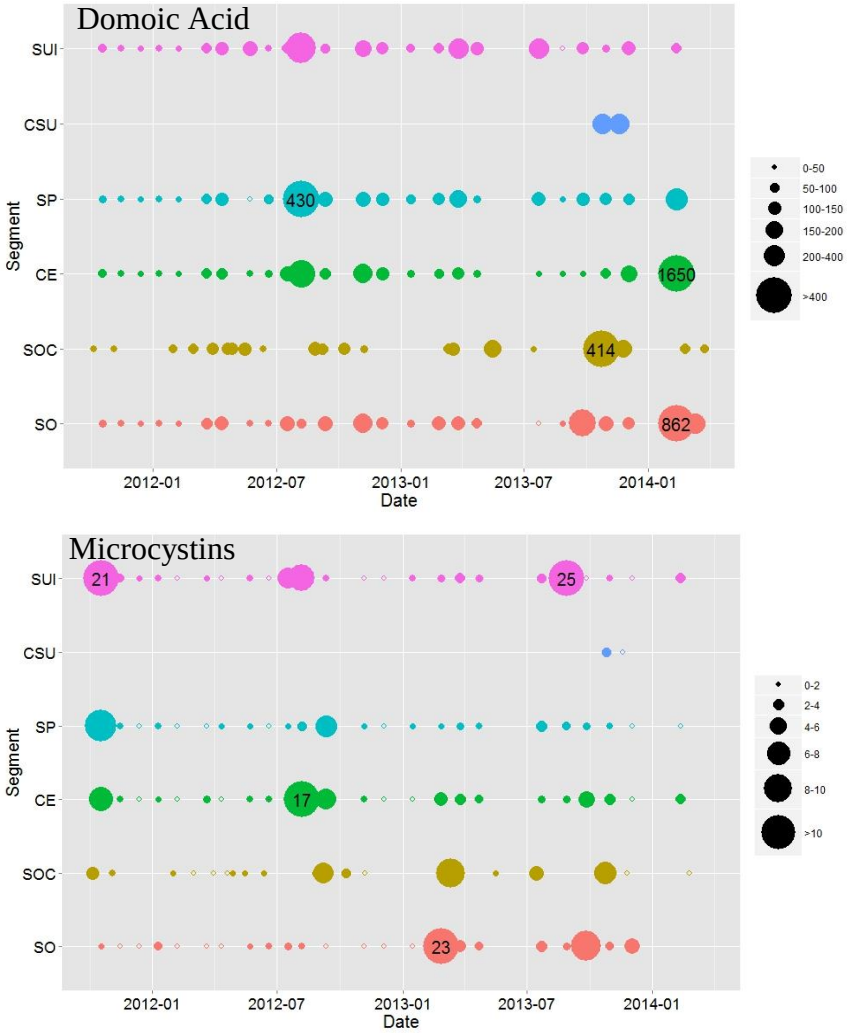
outside of this group and retains oversight over prioritization of these funds. The description below includes all nutrient strategy activities, with RMP-funded projects noted.

Meetings

In accordance with the newly-developed governance structure for the Nutrient Management Strategy, a Nutrient Technical Workgroup and a Steering Committee have been convened in Q2 2014. A project-specific technical team meeting also took place for the Assessment Framework Development (May 19th, 2014).

Milestones

- An interim report on the Solid Phase Absorption Toxin Tracking (SPATT) project for detecting algal toxins was recently completed (R. Kudela, UCSC). SPATT samples have been deployed regularly in-situ and on transect cruises since 2011 (2013 samples funded by RMP) and preliminary analysis has begun (see figure below). 69% of samples were positive for miscrocystins and 99% were positive for domoic acid. A no-cost extension has been requested in order to allow for sample collection and analysis to continue through September 2014



Concentrations of domoic acid and microcystins detected on SPATT resins (in ng/g) during transect deployments in SFB, by subembayment (SO=South, SOC=South+Central, CE= Central, SP=San Pablo, CSU=Central+ Suisun, SUI=Suisun)

Circles that are open, but not filled, indicate where samples were taken but toxins were not detected

Size of the bubble corresponds to concentration detected on the SPATT resin (in ng/g), and UCSC researchers are currently refining the relationship between SPATT resin concentration and environmental concentrations

- A draft "Development Plan

for the San Francisco Bay Nutrient Monitoring Program" was completed in March 2014 and recently sent to the TRC/SC for comment. This report makes initial recommendations for future monitoring program structure and identifies highest priority data investigations/pilot studies to address remaining questions, and the report will be revised/updated as the results become available. [Funded in part by the RMP].

Activities for the Third Quarter of 2014

- "Scientific Foundation for a San Francisco Bay Nutrient Strategy" (formerly known as "Nutrient Conceptual Model") will be completed in June 2014 [Funded by the RMP]
- A technical memo on the results of WY2012/WY2013 nutrient stormwater sampling is nearly complete and is expected in June 2014 [Funded by the RMP]
- Two deliverables for the moored sensor pilot program are expected in June 2014. One is a technical report that summarizes lessons learned about sensor operation, scientific analysis of pilot year data and recommendations for year 2 of the moored sensor program. The second is a manual that will provide guidance on sensor servicing and maintenance [Funded by the RMP]
- The detailed modeling workplan is currently being developed and is expected to be completed in July 2014, after which model development will being [Funded by the RMP]
- A draft report that synthesizes seasonal, spatial and temporal trends in ecosystem drivers (nutrients, sediments) and responses (chlorophyll, dissolved oxygen) in Lower South Bay is currently in development and is expected to be completed in July 2014.
- A beta web-tool for visualizing real-time moored sensor data from SFEI and USGS instruments is expected to be completed in July 2014.

For more information, please contact David Senn at davids@sfei.org or Emily Novick emilyn@sfei.org.

F. Status and Trends Sport Fish

Purpose of Workgroup

The purpose of the workgroup is to design RMP studies relating to sport fish contamination. RMP sport fish monitoring has been switched from a three-year cycle to a five-year cycle to maximize cost-effectiveness and to coordinate with state-wide monitoring efforts. The next round of sampling will occur this summer.

Meetings

The Sportfish Workgroup met on December 20th, 2013 to discuss the RMP's 2014 sport fish sampling effort, including the contaminants, species, and regions that will be sampled. Sampling will occur in the spring for Shiner Surfperch and in the summer for all other sport fish species.

Activities for the Third Quarter of 2014:

- We are coordinating field activities, lab analysis, and data management for sport fish monitoring.

For more information, please contact Jay Davis at jay@sfei.org.

G. Selenium Strategy

The RMP is developing of a Selenium Strategy in response to the upcoming North Bay Selenium TMDL. The Strategy will be focused solely on monitoring. The first meeting was held on April 22nd, 2014 and the second meeting was held on June 3rd, 2014. During the first meeting, the scope and goals of the Strategy were discussed; at the second meeting, special studies for 2015 were recommended.

For more information, please contact Jay Davis at jay@sfei.org.

H. Items of Interest

Delta

The Technical Advisory Committee (TAC) and its four ad-hoc subgroups are in the process of developing various components of the initial monitoring design for the initial priorities of the program: current use pesticides, methylmercury, nutrients, and pathogens (*Cryptosporidium and Giardia lamblia*). POTWs have identified a station network of proposed key locations for reasonable potential analysis. The plan is to integrate these various elements into a unifying design by September, with the intent to start collecting samples in 2015. SFEI staff currently engaged in these planning efforts include: Thomas Jabusch, Jay Davis, David Senn, and April Robinson.

For more information, contact the Delta RMP Project Lead, Thomas Jabusch, at thomas@sfei.org.

Resilient Landscapes

The Resilient Landscapes team is contributing to an animated flyover of the historical Delta. The flyover will visualize what the Delta was like a century and a half ago, and builds on the Sacramento-San Joaquin Delta Historical Ecology report, developed by the Resilient Landscapes team in 2012 (Alison Whipple, Robin Grossinger, et al.). The project is funded by Metropolitan Water District, and the team is working closely with 34 North in building the animation. The animation will be premiered by Robin Grossinger at the Orange County Water Summit May 16th. http://www.ocwatersummit.com/

EcoAtlas Updates

The USEPA recently awarded three Wetland Program Development Grants to enhance and support EcoAtlas. In partnership with the Delta Conservancy and State Water Board, SFEI staff

will (1) add new quantitative field data layers, and enhance the tool's visualization and dynamic project reporting; (2) develop training materials and cost estimates for regional stewardship of EcoAtlas; and (3) create a business plan to sustain EcoAtlas as an interagency tool into the future. In addition to enhancing the functionality in EcoAtlas, this funding will contribute to supporting wetland protection in California.

I. Transitions

Meg Sedlak will be taking a leave of absence to spend time with her two teenage kids, her husband (now published author – Water 4.0), and her deranged but always entertaining dog, Enkidu. She hopes to be back at the Institute in some capacity in a year or so. Phil Trowbridge has joined the Institute as the next RMP program manager. Phil is an MIT engineer who has over 14 years' experience running an estuary program on the east coast. An avid marathon runner and outdoor enthusiast, Phil is looking forward to working with the RMP community to better understanding the Bay ecosystem.

RMP Deliverables Scorecard

Deliverable	Lead	Deliverable Type	Start Year	Original Due	Current Due	Stoplight	Comments	Months Overdue
Contaminant Fate								
1) Mercury Synthesis and Conceptual Model Update	JD	Report	2011	Aug-11	Jan-14	✓	Completed in 2014.	34
2) PCB Conceptual Model	JD	Report	2011	Mar-12	Jun-14	■	Final will be completed by June 30.	27
Emerging Contaminants								
3) Broadscan Screening of Biota for EC	MS	Report	2012	Mar-12	Jul-14	■	Received draft seal and mussel progress report. Expecting manuscripts.	27
4) PFCs in Bay Biota	MS	Report	2012	Mar-13	Aug-14	■	Draft to be completed by end of August.	15
5) Developing Bioanalytical Tools (Year 1)	MS	Report	2013	Dec-13	Jun-14	■	Progress status report for year 1 sent to workgroup. Will have final year one report in June.	6
6) PBDE Summary Report	MS/RS	Report	2013	Mar-13	Mar-14	✓	Report completed. Working on manuscript	15
7) Developing Bioanalytical Tools (Year 2)	MS	Report	2014	Apr-15		●		
8) Effects of particle size/shape on toxicity	MS	Report	2014	Dec-14		●		
Exposure and Effects								
9) Benthic Assessment for Mesohaline	MS	Report	2012	Dec-13	Mar-14	✓	BPJ exercise and year one draft progress report completed.	6
10) Copper and the olfactory nerve	MS	Report	2013	Dec-14		●	Federal budget shortfall resulted in switch from Chinook to Coho.	
11) Develop Selenium Strategy	JD	Task	2014	Dec-14		●	Held 2 meetings.	
12) Dioxin Sportfish Report	JD	Report	2014	Dec-15		●		
13) Impacts of Dredging on Benthic Habitats	MS	Report	2014	Dec-16		●	Received funds. Contract underway.	
Nutrients								

Deliverable	Lead	Deliverable Type	Start Year	Original Due	Current Due	Stoplight	Comments	Months Overdue
Nutrients								
14) Nutrients Conceptual Model and Scenario Building	DS	Report	2012	Dec-12	Jul-14		Final formatting stage. Final will be completed in July.	18
15) Nutrients Stormwater Sampling (WY 2013)	DS	Field Sampling	2013	Dec-13	Jun-14		Draft report in final internal review.	6
16) Nutrient Model Development	DS/DY	Task	2013	Dec-14			Model development to begin after detailed workplan plan is finalized (Jan 2014).	
17) Detailed Nutrient Modeling Workplan	DS	Report	2013	Jan-14	May-14		Will balance between hydrodynamic and water quality models.	5
18) Moored Sensor Pilot Program	DS	Report	2013	May-14	Jun-14		3 sensors now deployed. Scientific investigations and data analysis underway.	1
19) Algal Biotoxin Monitoring	RK	Field Sampling	2013	May-14			Preparing technical memorandum.	1
20) Nutrient Monitoring Program Development	DS	Report	2014	Dec-14				
21) Moored Sensor Monitoring Program - Year 2	DS	Report	2014	May-15			Sensors installed. Preparing maintenance manual.	
Status and Trends								
22) USGS South Bay Sediment Budget Factsheet	JD	Factsheet	2011	Mar-13	Apr-14		In final formatting.	15
23) S&T Bird Egg Report (2006/2009/2012)	JR	Report	2012	Jan-13	Dec-14		Data analysis and writing in progress. Draft in September 2014, final in December 2014.	17
24) Updated Ambient Sediment Threshold Concentrations	EWN	Memo	2013	Jan-14			Memo completed. Need to revise based on EBMUD reanalyses.	5
25) Coring Manuscript	DY	Manuscript	2013	Oct-13	Jul-14		Waiting for comments from co-authors.	8
26) RMP Website Update	EWN	Task	on-going					
Sources Pathways and Loadings								

Deliverable	Lead	Deliverable Type	Start Year	Original Due	Current Due	Stoplight	Comments	Months Overdue
Sources Pathways and Loadings								
27) Load Monitoring - EMC Development (2014)	LM	Task	2014	Dec-14			To be discussed at SC meeting.	
28) Nutrients Stormwater measurements (WY2014)	DS	Report	2014	Dec-14				
29) Load Monitoring in Representative Watersheds (WY2014)	LM	Task	2014	Dec-14				
30) Develop and Update Spreadsheet Model - Year 5	LM	Report	2014	Sep-14				