



**RMP Exposure and Effects Workgroup Meeting  
October 18th, 2011**

**DRAFT SUMMARY**

**Attendees**

Kevin Aceituno (FWS Sacramento)	Rachel Allen (SFEI)
Brian Anderson (UC Davis)	Jay Davis (SFEI)
Steve Bay (SCCWRP)	Rainer Hoenicke (SFEI)
Bruce Herblin (USEPA)	Meg Sedlak (SFEI)
Cathy Johnson (FWS Sacramento)	
Michael Kellogg (SFPUC)	
Harry Ohlendorf (CH2M HILL)	
Bryn Phillips (UC Davis)	
Barnett Rattner (USGS)	
Dan Schlenk (UC Riverside)	
Karen Taberski (SFB RWQCB)	
Chris Vulpe (UC Berkeley)	
Steve Weisberg (SCCWRP)	
Don Weston (UC Berkeley)	

**Via Telephone**

Josh Ackerman (USGS)  
 Joe Dillon (NOAA Fisheries)  
 Arleen Feng (ACCWP for BASMAA)  
 Michael Fry (FWS Honolulu)  
 Letitia Grenier (SFEI)  
 Trish Mulvey (SFEI Board)

**1. Introductions and Review of Agenda**

Meg Sedlak began the meeting with introductions and a review of the agenda.

**2. RMP Planning Update**

Jay Davis outlined the new RMP planning cycle. The RMP Steering Committee (SC) is beginning to do more “steering”, by providing direction to the Technical Review Committee (TRC) and the workgroups about which broad areas of the program they intend to focus resources on. The RMP Master Plan, updated periodically, illustrates the overall information needs and upcoming management decisions, and outlines the efforts within each of the program areas to accomplish these goals. (The Master Plan was distributed to the group.) The RMP Master Plan Meeting, where the SC will set priorities

and potential resources for 2013 and beyond, will occur on Friday, October 21<sup>st</sup>. The EEWG has an opportunity to request funding for exposure and effects studies by highlighting information needs and high priority studies before this meeting. The studies that are most valuable to the SC are those that will help improve the remediation of the Bay (e.g., establishes thresholds, assists in developing information for 303 (d) lists, etc.). Jay also added that the Status and Trends component of the program is being reevaluated, which will potentially free up more funding for Special Studies; however, there is still a lot of competition for this limited funding.

Arleen Feng asked how matching funds and partners were displayed on the Master Plan. Jay Davis indicated that the Master Plan is starting to recognize matching funds, from the EPA and NOAA, for example, but the format for this is still a work in progress. Harry Ohlendorf suggested that the effects questions, listed on page 22 of the Master Plan, should be updated to reflect our progress in addressing them.

Arleen Feng asked about the progress of the copper and salmon study being conducted by David Baldwin. Meg Sedlak noted that while there have been considerable administrative difficulties getting the funding to Dr. Baldwin, preliminary research is underway to evaluate the effects of Cu in seawater on salmon. Funding for 2011 will be used to establish the effects of DOC on these experiments. Ms. Sedlak indicated that the current embryos should be ready for the DOC tests in the spring.

Steve Weisberg noted that the EEWG was initially started in response to a 5 year program review of the RMP, and asked if there were plans to do another program review. Jay Davis noted that the SC will also discuss this at the Master Planning meeting, but that there are no plans for a comprehensive review in the short term, because so much external review is received on an on-going basis from the workgroups.

#### **Action Items:**

- Update the Master Plan to reflect matching funds and progress in addressing Exposure and Effects priority questions.

### **3. Summary of the Exposure and Effects Pilot Study**

Meg Sedlak gave a summary of the Exposure and Effects Pilot Study (EEPS) to the workgroup. After receiving input from the workgroup on the findings and next steps, the summary will be written up in a brief memorandum for the Water Board. Meg presented the studies on birds, fish, benthos, and seals that have been performed since 2002 as part of EEPS.

Birds studies have focused on terns, cormorants, and diving ducks. Results suggest that terns are exposed to Hg at levels that are affecting their reproduction/development, but that the TMDL targets for Hg exposure should be protective of the population. Cormorants serve as a better indicator of spatial and temporal trends than terns. Diving ducks, originally monitored in 2002-2005, had concentrations exceeding the OEHHA human health advisory for selenium, however, they are not suitable as a trends indicator

and because relatively few individuals actually consume ducks, monitoring was discontinued. Based on recommendations from EEWG, TRC and SC, monitoring terns and cormorants was included in the RMP Status and Trends (S&T) program in 2009. Ms. Sedlak provided a summary table indicating the success of each of the species as an indicator. The criteria for inclusion into Status and Trends were developed in 2004.

Fish studies have focused on surfperch and sculpin, as well as herring and halibut, for effects thresholds, and small fish for exposure. It appears that specific locations within the Bay can disrupt the endocrine system of sculpin/surfperch, and that PAHs may affect early life stage development of herring and halibut. Small fish (silverside and topsmelt) serve as a good spatial and temporal indicator for both mercury and PCB uptake to the food web. Meg Sedlak recommended that the EEWG consider incorporating small fish into the RMP S&T program. This recommendation will need to be vetted by the EEWG, Hg Strategy, and PCB Strategy teams. Additional fish effects studies will be discussed in the spring of 2012.

Benthos assemblage analyses and sediment toxicity were added to the S&T analyses in 2008 to complete the “sediment triad”. It is still unclear which contaminants are causing effects to benthic organisms, however Meg Sedlak recommended continuing to include benthic assemblages in the S&T program, and continuing to develop methods to identify sediment stressors.

Seals have served as good indicators of exposure levels at the top of the food chain, and the work to date has resulted in a strong partnership with The Marine Mammal Center. However, Meg Sedlak did not recommend further work on seals in the short term.

Steve Weisberg stated that the presentation did a good job of capturing a large body of work, and that this has been an excellent investment by the RMP in general. He noted that these studies have in large part leveraged RMP funding quite effectively, and have established exceptional baselines in three media. He asked that a slide be added at the end that summarizes the recommendations of the EEWG. Bruce Herblin suggested that the number of publications that have come out of this work would serve as a good indicator of the return on the investment.

Meg Sedlak asked the workgroup to review the recommendations on the indicator species and provided the committee with copies of the recommendations.

**Action Items:**

- Get feedback from the workgroup on the effectiveness of the indicator species for birds, fish, and benthos and recommendations for the future.
- Add a slide to the presentation that summarizes the approval and recommendations of the EEWG.

#### 4. Sediment Toxicity: Molecular TIEs

Steve Bay updated the workgroup on the progress developing molecular tools for stressor identification in sediment toxicity tests. He noted that traditional TIE results have frequently been inconclusive or non-specific. A molecular approach, which detects changes in the gene transcription of test organisms in response to contaminants in their environment, could result in greater relevance, sensitivity, and specificity. The methods are still in development, so the RMP funding was used to create a “training dataset”, in which test organisms were exposed to a set of contaminants at varying concentrations. The responses to these contaminants start to build the library of gene responses that will be used in TIEs. Steve Bay noted that the doses used were typically near the LOEC for the test organism. For cadmium, the dose used was 10,000 µg/L because the amphipods (*Eohaustorius estuarius*) are not very sensitive to metals.

The gene microarrays produce a large amount of data, and exposure to different contaminants produces differing patterns in the gene expression. Steve Bay noted that the “tail” shown on the plot of gene expression after exposure to copper may be an artifact of the sample treatment, which is typical of the commercial arrays used in this study.

While each replicate consists of a composite of 5 animals, Steve Bay noted that there is considerable variability between the composites, likely due to noise in the biology. In each set of replicates, the genes most likely to indicate a contaminant specific response were identified, and a subset of these genes was unique to each contaminant. Cluster analysis was used to group the gene responses – for the most part different dose levels grouped together, but occasionally they grouped in distinct clusters. For bifenthrin, for example, only 10% of the genes between the high and low doses overlapped.

The molecular approach was also applied to 3 samples, to begin to evaluate its ability at toxicity identification. It correctly identified the two known samples, where the toxicity was due to pyrethroids, and indicated that pyrethroids as well as trace organics are contributing to toxicity in an unidentified sample from San Francisco Bay.

Next steps for the project include an inter-lab comparison study, development of the stressor identification approach, and expanding the training data set. The other labs that might potentially be involved in the calibration effort include the University of Massachusetts, Environment Canada, and Hollings Marine Lab.

Don Weston asked if the molecular TIE project is asking the correct question “what is causing mortality?”. He suggested that perhaps the molecular approach is asking “what is causing differential gene expression?”.

Harry Ohlendorf asked if the training data set included combinations of contaminants. Steve Bay indicated that this has not yet been attempted, but that this is the ultimate goal.

## 5. Sediment Toxicity - Causes of Sediment Toxicity

Bryn Phillips updated the group on the on-going effort to determine causes of toxicity in SF Bay sediment. San Francisco Bay has consistently seen moderate toxicity at a large number of stations, yet never established the causes of this toxicity. A 2007-2008 study that revisited Mission Creek, a site of high toxicity, indicated that toxicity was due to a mixture of PAHs, pesticides, and possibly chlordane. Don Weston noted that these conclusions did not seem to be drawn from TIE manipulations, but rather from comparisons to LC-50s and other methods. Bryn Phillips concurred, noting that the TIEs narrowed it down to a mix of organics, while other methods added the additional detail.

The current study was designed to fill data gaps from the previous efforts and develop effects thresholds (LC-50s) for key contaminants of concern: chlordane, cyfluthrin, and pyrene. Don Weston asked which was more toxic, cis- or trans- chlordane. Bryn Phillips indicated that neither is very toxic to *E. estuarius* – the LC50 was greater than 13,400 ng/g dw for both compounds. This indicates that chlordane is not itself toxic, even though it has a low ERM. The group digressed into a discussion of ERMs. The chlordane ERM originated in Ed Long's work in 1995, and was propagated by Rusty Fairey. Steve Bay clarified that the ERM was developed from field data with contaminant mixtures, and chlordane is a good marker for urban runoff in contaminated sediments.

Bryn Phillips described the method development in whole sediment and interstitial water. In both methods, extractions with a solid phase are successfully able to remove the toxicity, but attempts to recover the toxicity were unsuccessful. The group also held a workshop in April 2010, where the TIE flowchart was refined. He noted that the research is on the right track; however, relatively few organizations continue to support TIE development (USEPA is no longer supporting this work), only the Granite Canyon Lab, SCCWRP, and commercial labs are currently developing these methods.

The group reviewed a figure showing toxicity as a function of grain size; the figure shows a correlation between decreasing fines and increasing toxicity. Bryn Phillips suggested that while *E. estuarius* are largely unaffected by grain size, shape may have an effect, and it has not been investigated. Brian Anderson noted that Dr. Ivano Aiello of MLML has seen considerable variability in particle shape in sediment samples, particularly in clay. Arleen Feng asked about the definition of clay, and whether it was based on life history or behavioral ecology of the amphipods. Brian Anderson clarified that USGS guidance has defined it at 4 µm, an operational definition. Dan Schlenk noted that nanoparticle evaluation methods, including identification and characterization, have progressed considerably, and could be applied to sediment to determine surface area, size, shape, and distributions. Chris Vulpe noted that Ben Gilbert at Lawrence Berkeley Labs works on these types of analyses.

Karen Taberski asked about the toxicity of the samples that were collected at Mission Creek in 2011 as part of the 2011-2012 sediment hotspots study. Brian Anderson noted that there was 0% survival in these samples.

Bryn Phillips also noted that, after a few years of intercomparison studies, the freshwater toxicity testing has recently moved to *H. azteca* and *C. dubia* to replace *E. estuarius* and *M. galloprovincialis*.

## 6. Effects on Birds - PBDEs in Terns

Barnett Rattner presented the results of a study investigating the effects of PBDEs on the growth of common terns. Previous studies had established that American Kestrels are sensitive to PBDEs at low levels (LOEL = 1.8 µg/g ww), and that Forster's tern eggs in San Francisco Bay have been found to contain concentrations of PBDEs that exceed this level. Therefore, the study was designed to determine the toxicity of DE-71 (a PBDE mixture) to common tern embryonic survival, pipping, and hatching success, as well as its sublethal effects on tern hatchlings including growth, deformities, and biochemical endpoints. No significant dose-response relationship on survival, pipping, or hatching in common terns was found, and only subtle changes were seen in organ weights. Therefore, it was concluded that common terns are no more sensitive to PBDEs than kestrels, and that there is a similar pattern of embryotoxicity to PBDEs as to PCBs and methylmercury.

Jay Davis asked if the kestrel results seen in this study were similar to the earlier results that led to the LOEC of 1.8 µg/g. Barnett Rattner noted that they were not as dramatic, but did not invalidate the earlier results.

Chris Vulpe asked what the driver of this study was. Letitia Grenier noted that it was designed to develop a rough estimate of the toxicity of PBDEs to terns, to place the BDE concentrations observed in Bay terns into context and to help answer the question of whether regulators should be concerned about these levels.

## 7. Effects on Birds and Benthos – Next Steps

Jay Davis asked the workgroup to brainstorm and evaluate next steps for birds and sediment toxicity/ benthos exposure and effects studies, to feed in to the Master Planning meeting. He noted that the criteria for recommending a study include its ability to influence decision-making, its capacity for partnering or leveraging, the degree of consensus within the workgroup, and its urgency.

### *Birds*

Harry Ohlendorf suggested that given that the high levels of PBDEs in tern eggs were detected about 10 years ago, that they be analyzed again for PBDEs. Josh Ackerman confirmed that there should be enough biomass in the eggs to perform these analyses. (It was confirmed during the meeting that the 2009 tern eggs were analyzed for PBDEs.)

Rainer Hoenicke asked about monitoring substitute products for PBDEs. Jay Davis noted that cormorant eggs are currently being monitored for alternative flame retardants.

Barnett Rattner is working on developing effects thresholds to organophosphorous flame retardants in adult kestrels with Environment Canada.

Josh Ackerman suggested that next steps start looking at population level effects such as net survival and hatching success, and creating a modeling framework. Harry Ohlendorf suggested that a population level study include a field component as well as a modeling component. Barnett Rattner asked how carefully bird populations in the bay are being monitored. Harry Ohlendorf indicated that there is no on-going monitoring of populations, however Rainer Hoenicke noted that the recently released State of the Bay report shows some populations in danger and correlates population health with habitat limitations. Currently, populations are limited by available habitat, but as habitat is restored, the limiting factor may change.

Steve Weisberg indicated that the bird work that has been performed so far is of excellent quality, and that there are no studies of immediate importance.

Letitia Grenier suggested that next steps could investigate birds in salt marshes. Song birds in salt marshes appear to be impacted by methylmercury at low concentrations, and methylmercury exposure appears to be positively correlated with salinity. Therefore, as marshes are restored, more information on the correlation between fresh water and mercury concentrations could influence the designs behind the restoration efforts. Trish Mulvey suggested that alternative funding should be pursued for the modeling and salt marsh ideas, because they are not of immediate interest to the RMP. Arleen Feng noted that marsh restoration is important for mercury cycling, but not of interest to RMP stakeholders. Michael Fry asked if there was a party responsible for Hg. Arleen Feng clarified that all the dischargers are responsible for mercury inputs, but that cycling in salt marshes is beyond their purview.

#### *Sediment Toxicity and Benthos*

Karen Taberski asked about a write-up on the status of the Sediment Quality Objectives. Jay Davis indicated that the upcoming National Coastal Condition Assessment will address this. Steve Weisberg clarified that there is an agreed upon benthic index in certain habitats, however it is less likely in mesohaline or tidal-fresh habitats.

Jay Davis noted that figuring out sediment toxicity is a priority for managers. Brian Anderson noted that the conventional methods for TIEs are developed, but that adding together molecular and conventional methods could improve chances for success. Chris Vulpe indicated that defining the endpoint more realistically, differentiating between pyrethroids and metals, for example, could result in more short term success that could guide future work. So, more investment in TIEs could result in moderate improvements in the methods.

Karen Taberski supported addressing the issue of grain size. Brian Anderson noted that an effort to determine if grain size or shape affects amphipod toxicity could require large amounts of funding and a large collaborative effort. He would need to have a fuller

discussion on the scope of such a project to estimate the funding required. Joe Dillon suggested that the wrong amphipod is being used for toxicity tests in the Bay.

Steve Bay noted that SF Bay faces two issues with sediment toxicity: 1) widespread moderate toxicity, and 2) hotspots. Given the success of last year's stressor ID workshop, he suggested convening a second workshop to address moderate toxicity.

### ***Closed Session***

In attendance: Steve Weisberg, Harry Ohlendorf, Dan Schlenk, Don Weston, Karen Taberski, Jay Davis, Mike Kellogg, Kevin Aceituno, Cathy Johnson, Jay Davis, Meg Sedlak, Rachel Allen

Via telephone: Joe Dillon, Arleen Feng

Steve Weisberg initiated the conversation by disclosing his conflict of interest as an advisor: SCCWRP has received funding for the molecular TIE study, as well as other funding. He therefore stated his opinions, but indicated that he would refrain from voting.

The group agreed on three areas of scientific and regulatory interest: 1) moderate toxicity in Bay sediments, 2) benthic assemblages, and 3) birds.

#### 1) Moderate toxicity

The causes of the widespread moderate toxicity are largely unknown and a team of researchers broader than the Bay Area is needed to tackle these questions. This is therefore an urgent and feasible option for future studies. This topic could also address grain size or shape, as one of many possible causes of the moderate toxicity. One panel member suggested organizing a workshop on this topic through the Society of Environmental Toxicology and Chemistry (SETAC) Pellston workshops.

Regarding the theory of particle shape in sediment toxicity, one panel member suggested that there is no fundamental reason to infer a causal relationship. Sulfide, type of organic carbon, or any other unexplored factor could equally have an effect.

One participant indicated that the molecular TIE work is of the highest priority, because it may eventually be able to identify responsible parties. It was noted that dredgers would support revamping the toxicity tests, because the results highly affect the disposal location of dredged materials. The molecular TIE work should therefore continue, but additional funding partnerships will be required.

#### 2) Benthos

The interpretation of benthic data is part of the core RMP, but there is no group of experts available to make progress on this front. One participant indicated that assessing benthic communities is of urgent need.

### 3) Birds

One panel member noted that the bird work has a solid track record, and that this group would be well situated to continue into the next area of research: population estimations. Other participants suggested that the RMP bird work is complete for the time being, and that it should be re-evaluated in 10 years.

#### Summary:

The group agreed that a workshop bringing together national experts on sediment toxicity should be held to address the question of moderate toxicity in the Bay. It can consider grain size, historical TIEs, the use of SPMEs, and other improvements to TIE methods. Big decisions within the RMP should therefore be delayed until after this workshop. The workshop will need to bring in industry groups, academia, and the government, and should have a publication or book come out of it. This workshop is not mutually exclusive with continuing to pursue molecular TIEs, so both can be considered for the near future. Jay Davis clarified that if there is any funding left in the budget from the stressor ID workshop (originally scheduled to be the first of two), it will be applied to this workshop.

There was not enough time to receive input on the recommendations from the EEPS summary, so Meg Sedlak will send the slides to the panel members via email for their input.

#### Action Items:

- Meg Sedlak will follow up with panel members about the possibility of holding a Pellston workshop on moderate sediment toxicity in SF Bay.
- Receive written comments from workgroup advisors on the submitted reports.
- Meg Sedlak will send the recommendations from the EEPS summary to the panel members for their input.

#	Action Items – October 2011	Who?	When?	Status 5/8/2012
1	Update the Master Plan to reflect matching funds and progress in addressing Exposure and Effects priority questions.	Jay Davis		Annual update of Multi-Year Plan complete.
2	Get feedback from the workgroup on the effectiveness of the indicator species for birds, fish, and benthos and recommendations for the future.	Meg Sedlak		Mike Kellogg and Steve Weisberg provided comments.

3	Add a slide to the EEPS summary presentation that summarizes the approval and recommendations of the EEWG, and distribute the recommendations to the panel members for their input.	Meg Sedlak		In progress
4	Follow up with panel members about the possibility of holding a Pellston workshop on moderate sediment toxicity in SF Bay.	Meg Sedlak		Discussed at TRC and SC. Decided Pellston not appropriate venue for this discussion – proposal on May 2012 agenda.
5	Submit written comments on the draft reports.	Workgroup advisors		Molecular TIEs: Steve Weisberg's comments incorporated into document. Report finalized and posted to web. Causes of Sed Tox: Don Weston provided comments. Report finalized and posted to web. PBDEs in Terns: Report finalized and posted to web.