RMP Exposure and Effects Workgroup Meeting

July 6, 2009
DRAFT Meeting Minutes

In Attendance:

Josh Ackerman (USGS)
Michael Fry (American Bird Conservancy)
Michael Kellogg (SFPUC)
Dan Schlenk (UC Riverside)
Karen Taberski (SFB RWQCB)
Steve Weisberg (SCCWRP)
Don Weston (UC Berkeley)
Bryn Phillips (UC Davis)
Steve Bay (SCCWRP)
Dong-Fang Deng (UC Davis)
Dolly Basa (UC Davis)
Laura Hoberecht (NMFS)
Brian Anderson (UC Davis)
Peter Schafer (San Jose)
Arleen Feng (BASMAA)
Jay Davis (SFEI)
Jen Hunt (SFEI)
Sarah Lowe (SFEI)
Meg Sedlak (SFEI)
Aroon Melwani (SFEI)

A. Introductions and Review of Agenda

Meg Sedlak began with introductions and a review of the meeting agenda. She noted that the priority meeting items include review and prioritization of Pilot and Special Study proposals for 2010. The 2010 budget for pilot studies is approximately $400,000 which will fund studies from all four RMP workgroups. The ranked pilot projects will be brought to the TRC and SC for approval. Ms. Sedlak indicated that the workgroup no longer has a $200,000 per year allocation. Pilot and special studies from all four workgroups will be reviewed and ranked for priority. Ms. Sedlak indicated that pilot and special studies which address Exposure and Effect Workgroup questions or RMP management questions should be given a higher priority.

B. Causes of Sediment Toxicity

Brian Anderson gave a presentation on the causes of sediment toxicity proposal. There have been high incidence of sediment toxicity in the Bay since early 1990s and understanding the causes of the toxicity is a high priority for the workgroup. The sediment toxicity work is also important for the SQO assessments. Dr. Anderson presented a workplan for 2009 which would provide LC-50 data for amphipods for high priority contaminants. Currently, there is a dearth of LC50 data for many environmental contaminants, making the process of interpreting Toxicity Identification Evaluations (TIEs) somewhat uncertain. The experimental design will include spiking reference sediment and water with chlordane, cyfluthrin and pyrene and using the chemistry data from LC-50 experiment to develop Phase 2 TIE methods.

The UC-Davis Granite Canyon group is currently working on dosing experiments to improve TIE procedures. Sediment samples are spiked with a resin that removes organics (when organic compound is suspected culprit) - if toxicity is reduced then organic is the probable cause. The resin containing the organic contaminants is then spiked back into water to perform toxicity tests to determine if resin with organics is toxic to test organism. The method is somewhat confounded because the resin currently used (amberlite) can be a sink and may draw more chemicals from the sediment than would be biologically available. Dr. Anderson indicated that the group is using a new method that involves centrifuging sediment samples to remove the interstitial water and then employing SPMEs to remove contaminants.

The group is also evaluating interstitial water using a special type of column to remove the organics (HLB). Eluate from column is used to conduct toxicity tests. If there is toxicity is identified, then it is likely that an organic contaminant is the cause. Dr. Anderson indicated that the eluate method using pore water has shown mixed results in toxicity tests. Partly, this is because the binding capacity of the column varies depending on the chemicals that are present. HLB column and resin are supposed to remove the same chemicals in their respective matrix. Dan Schlenk indicated that using SPME is difficult to remove and evaluate contaminants. He suggested that Brian Anderson contact Jay Gans at UC-Riverside to discuss this issue. Also the uptake into SPME may be a function of the organic carbon content of the sediment. Preliminary tests were 0.5 -3.5 total organic carbon content sediment. For very contaminated sites, the resin and the HLB column may become saturated. The group agreed that the SPME method requires a lot of characterization. For example, equilibrium constants need to be calculated for each contaminant.

The EEWG recommended establishing a workgroup to discuss and coordinate issues surrounding causes of sediment toxicity, TIEs, and amphipod LC-50s. The EEWG recommended bringing in individuals with a background in chemistry to assist in this discussion particularly with regard to the design of sediment TIE experiments. Most sediments are moderately contaminated and TIEs are not very conclusive in moderately contaminated areas. The EEWG encourage the group to work cooperatively and to share information such as LC-50s. The group will also look at non-contaminant factors that decrease or increase mortality such as total organic carbon. Brian Anderson indicated that Granite Canyon was working with UC-Berkeley to share samples on a study looking at use of gene microarrays for evaluating amphipod toxicity.

C. Benthos Workshop and Plans for 2009

Aroon Melwani presented an update on the Benthic Workgroup. The Workgroup is using the sediment triad data to answer RMP Level I and II questions. There is currently no benthic index for oligohaline environments. The Workgroup held its first workshop in June 2009. This is a collaborative effort with SQO Phase II in the Delta. The long term goal is to develop benthic assessment methods for the San Francisco Estuary/Delta assemblages – a priority is mesohaline. The immediate goals are to review data and agree upon assessment methods for mesohaline benthic index. Work completed to date includes identification of the benthic assemblage into four general groupings: Delta/

freshwater, oligohaline, mesohaline, and polyhaline. There are still questions on how to assess mesohaline assemblage. The group has sent a list of species to experts for them to rank importance. Statistical tests will be performed on these results in order to identify the mesohaline assemblage.

Next steps include getting habitat variables together, conducting Best Professional Judgment exercises, revise existing mesohaline index or create new index, and hold a second Benthic Workgroup meeting.

Karen Taberski asked whether the $60,000 set aside for the sediment toxicity in 2010 could be used to fund the pilot and special study from UC-Berkeley and SCCWRP. (*The Toxicity workgroup was queried after the meeting and it was agreed to using this funding for this pilot and special study.*)

D. Small Fish Study – Update

Ben Greenfield provided an update on the small fish study. Seasonal trends in peak mercury uptake was seen at four stations including MLK Regional Shoreline and three stations sampled by USFWS Stockton office. Using size corrected mean topsmelt mercury and selenium fish concentrations over time, peak mercury concentration was observed in late winter at two locations. For MLK arrow goby peak was in July and early September. This was a very different pattern than topsmelt. The size-mercury relationship breaks down in months where mercury is elevated. This suggests a pulse of methylmercury in smaller fish due to a peak in prey concentrations. Gobies are resident and have slow growth and are epi-benthic. There is a mercury fluctuation in the fish at the same lengths over a year time period. Michael Fry asked whether they could depurate mercury over the year or depurate mercury via spawning? It is believed that spawning loss of mercury from fish is low. Loss is an important factor to consider. Dan Schlenk asked whether the collected gobies sexually mature?

Spatial analysis from probabilistic samples of the Bay shoreline including both enclosed and open water sites and potential mercury source sites (industrial, WWTP, contaminated sediments, near wetlands). Silversides from the lower South Bay have the highest concentrations. But there is within site variability. Spatially, source sites were not more contaminated than non-source sites. Silversides collected near wastewater treatment plants had lower concentrations of mercury which was a surprising finding. Topsmelt from the Alviso Slough site were high in mercury. Spatially there was more variation in lower South Bay while there were more constant concentrations at San Francisco sites. At the same sites, silverside and topsmelt diets are likely very similar. Silversides, which tend to be more inland in lower salinity waters, are generally 3 to 4 times higher in mercury. Some local embayments seem to be higher such as MLK shoreline and Tiburon. There was no relationship between fish mercury levels and wetlands.

Samples were also collected for mercury isotopes and for diffusive gradient thin film (DGT) study. DGTs are analogous to SPME and can provide estimates of bioavailable methylmercury. Correlations between DGT and small fish mercury were very weak;

however, the group has embarked on several efforts to improve the experimental design (e.g., deploying the DGTs over the same time as the fish residency).

Next steps: there will be no wetland strata for 2009 sampling; we will be deleting some sites in areas where the mercury variation was small (SF) and adding sites near known mercury sources. We will be collecting samples in Fall 2009 and leaving DGTs installed for one month instead of one week.

Management implications of this work: Site type patterns will illuminate unnecessary management efforts; project results will identify priority areas for TMDL efforts and be used to assess risks to wildlife. Results may also be used for Bay margin assessment, which is part of the RMP mercury strategy. The committee requested that Ben Greenfield gives a background MQs presentation to the group at the next meeting.

E. Copper and its Potential Effects on Salmonids

Dave Baldwin presented a summary of a potential pilot study for 2010. Dissolved copper is toxic at low ug/L concentrations in freshwater. Dissovled copper is present in the environment as a result of the use of copper-containing pesticides, brake pads, and industrial discharge. This research will focus on the impact of copper to salmonid olfactory nerves which in part guide their predatory (flight) response. The project will evaluate a variety of biological endpoints including: olfaction (odor response); links to behavior (alarm response) and survival/reproduction (predator avoidance).

Olfaction study: The study will record electrode activity in response to odor. The fish will be exposed to copper 30 minutes. Dr. Baldwin indicated that the response to copper exposure is fast. Fifty percent reduction in response of the olfactory nerve was seen at high copper levels. Researchers do not know the recovery time once exposure has ceased. However there is constant regeneration of the olfactory nerve. There are questions on copper speciation and effects. Salmon are able to close their nose but it is unknown if this is a response to pollutants.

Predatory response experiments show a reduction in the fish movement speed during alarm response. So far no known copper cytotoxicity has been identified. The NOAA group is able to track fish location in three-dimensions and compute swimming speed and measure difference post introduced odor. One of the test involves introducing an alarm odor – exposed fish start swimming around – non-exposed fish don't move. Predator fish such as cutthroat trout are able to catch the exposed fish more quickly as copper concentrations increase. This study will evaluate how are these behaviors affected by salinity. To date, Dr. Baldwin stated that there has been little observed effects of hardness and alkalinity; no effect of pH; and a decrease in toxicity with increasing dissolved organic carbon (DOC). DOC protects fish from exposure but not as dramatic as what biological ligand model would predict. There is a limited understanding of how water chemistry affects copper exposure or of sea-water phase salmon.

How would this be relevant to San Francisco Bay water chemistry? The study will use Chinook salmon and not Steelhead salmon. Results are not showing species differences

in copper exposure. The special study experiment would use SF Bay relevant water chemistry. Dan Schlenk asked What stage fish would be used? Dr. Baldwin indicated that they would focus on early smolt and pre-smolt since this represents San Francisco Bay residence life stage. Exposures will occur post seawater introduction. There is a potential multiple phase issue – which smolt stage would be more sensitive is unknown. Dan Schlenk asked how have results from experiments influenced water quality regulation from Washington State and would we use this in San Francisco Bay? Dr. Baldwin was uncertain about this. Additional work would be needed to relate sublethal effects to population effects and establish a water quality standard. Data used on ESA consultations on a site specific basis.

Arlene Feng indicated that BASMAA and dischargers will need to support some study of the effect of copper on salmon. How will results be applied to ambient conditions especially in highly variable water quality area such as San Francisco Bay? Using site water would be the optimum design; however, it may be logistically infeasible.

F. Harbor Seals

Elizabeth McHuron presented a potential special study looking at selenium affects in Harbor Seals. The San Francisco Bay Harbor seal population did not increase over the period 1970 to 2002. Factors affecting population include 1) change in prey populations; 2) pollutants; and disturbance of haulout sites. Seals are important indicators of Bay health. San Francisco Bay has the highest incidence of red pellaged seals in the world. Approximately 10-50% of seals at haul-out sites have red pellage. Causes of red pellage seals include algae, diet, genetics, and element deposition (iron). Increased selenium levels may cause degradation of hair shaft which increases surface area for iron to deposit and bind to hair shaft. The evidence to date suggests that the same individuals, post molt, develop the red pellage. Does the study answer RB questions for the TMDL? Barbara Baginska was very interested in the Selenium study. Is there evidence that red seals have higher Selenium? Bay harbor seals have higher Selenium levels than other seals on the Pacific coast. Do red pillaged seals have lower reproduction? No data on this. What about partial v. total red pellage – why? Is this dose dependant? Is red pellage gender related? It doesn't seem to be gender-related. During the molting process, fur is lost while skin and vibrissae do not molt.

G. Relative Sensititivity of Birds to PBDEs

Dr. Barnett Rattner of the Patuxent Wildlife Center and Letitia Grenier developed a special study to establish PBDE sensitivities in birds. The purpose of the study is provide context for the concentrations of PBDEs that we are observing in terns. Naomi Feger and Karen Taberski provided input and direction on this proposal. The project will collect recently laid, clean common tern eggs from Chesapeake Bay. Eggs will be brought back in an incubator at the Patuxent Wildlife Center laboratory to be incubated. Penta PBDE mix will be injected into the egg air cell. Eggs will be monitored at two to three day intervals to look at pipping and hatching success. Edema and teratogenicity, and P-450 will be measured and organ histopathology and skeletal defects examined. Pipping and hatching success will be quantified. Dr. Barnett estimates that adverse effects could

occur at concentrations as low as 1.8 ug/g in Kestrel eggs. The results of this experiment will be used to determine if terns are more/less sensitive than other species studied.

Analysis of eggs will be congener specific. The research group will use the Penta mix because the uptake of Octa mixture is very poor. In addition, the main congeners of the Penta mix frequently dominant Bay area biota (e.g., 47, 99 and 100). Rate of uptake in eggs is inversely related to the octanol-water partition coefficient. This proposed study will replicate the experiment that was conducted on Kestrel eggs. No other funding for this study has been sought. Questions: Why not collect eggs from San Francisco Bay and ship them back east? Based on the work conducted by the USGS Western Ecological Center, it is very difficult to successfully transport eggs from the Bay area and even harder to find a site with clean eggs. Are we in the range of effects thresholds for SF Bay birds? This is a big issue for 303(d) Water Board hearings. The Regional Water Quality Control Board needs PBDE endpoints to see what regulatory response is required. Is the injection solution toxic? Laboratory thresholds are usually different from field study derived thresholds. How will the laboratory thresholds be used to interpret field data? Laboratory and field efforts will be combined to try and determine field mortality thresholds. Osprey show 1 ug/g ww thresholds from field work. How do you eliminate other organic constituents from field study threshold derivations? What about egg shell thinning and PBDEs? There is conflicting evidence on this.

H. Mercury in Clapper rail and tern chicks/ Update on 2009 Pilot and Special studies – Tern mercury Studies.

Josh Ackerman of USGS presented a potential Clapper rail special study and gave an update on the tern mercury study. The studies are trying to establish a mercury hatchability effects threshold.

2009 Tern Work Update. Forster terns were found to have the highest mercury levels of any bird species studied in San Francisco Bay. USGS sampled 127 tern nests from six colonies as part of the microsampling project. The study monitored dead and living eggs and looked at mercury in fail-to-hatch eggs. Fail-to-hatch eggs have higher mercury. Abandoned eggs also have higher mercury. Using the surrogate egg technique (i.e., collecting one egg from a nest and follow hatching success of remaining eggs), it was determined that as egg mercury increases probability of egg hatching decreases. There is within clutch mercury variability as high as 35%.

USGS has successfully developed a microsampling technique where albumin from an egg is subsampled and analyzed for mercury. The hatchling success of these eggs is then monitored. Mercury and selenium were slightly negatively correlated in eggs. Mercury levels in 2008 eggs were lower than previous years – average levels were below the 1.0 ug/g effects threshold. Threshold for mercury effects in tern eggs is between 1.2 and 1.74 ug/g fww. Approximately 90 percent of the eggs hatch at 1.40 ug/g and 80 percent hatch at 2.10 ug/g. Microsampling technique is inconclusive whether there was a mercury effect – importance of Se needs to be explored further. Egg injected mercury probably more toxic than naturally deposited mercury according to Dr. Gary Heinz. Approximately 1.4 ug/g fww is an estimated effects threshold for reduced hatchability.

Cormorant study: Cormorant eggs have been collected from three sites but the South Bay colony has reduced nesting – long term monitoring may need to be relocated if this colony continues to fail.

2010 Tern proposal: Proposing to look at tern chick survival to determine if mercury levels decrease from hatch towards fledge then increase again pre-fledge. Decrease is due to feather depuration and growth dilution. Body burden may be same but concentration decreases. Pre-fledge - growth declines and concentrations increase. What are mercury effects on survival? Down feathers will be sampled and used to back calculate mercury in eggs. Survival of chicks will be tracked over 28 day pre-fledge lifestage. SBSP Restoration Project recently funded work to look at tern chick survival. Requesting funding to track an additional 30 chicks with radio transmitters and analyze 70 samples for mercury. Dr. Michael Fry asked whether transmitters increase predation on chicks? How would the results affect policy? USGS would recommend increasing the threshold level from 1 to 1.4 ug/g fww.

2010 Clapper rail proposal: San Francisco Bay Clapper rails have relatively high mercury levels. Reduced hatching success could be due to high mercury levels. There is an on-going three year USGS telemetry project where Clapper rail samples have been archived (e.g., blood, feathers, FTH eggs). This study is requesting money for mercury analysis. Some research questions: Can feathers be used to non-invasively monitor mercury in the species? Dr. Ackerman indicated that it may be possible to use feathers to calculate egg levels. This is a good opportunity to determine mercury risks to an endangered species. Feathers are not generally a good indicator of blood mercury levels but recent black rail data show a good relationship. This could be a good relationship for clapper rails as well. Is there any evidence that Clappers have higher mercury sensitivity? Virginia rails (related species) were more sensitive in egg injection studies.

I. Toxicity in Urban Creeks

Dr. Don Weston of UC-Berkeley presented a pilot study evaluating current use pesticide transport in urban creeks. As OC pesticide use has declined during the 1990s, pyrethroid use has increased. Monitoring results from local urban creeks showed that many sites have 100% of samples above the pyrethroid EC50 for *Hyalella azteca* toxicity. Most of these samples would not be toxic to *Ceriodaphnia*. LC50 and EC50 for pyrethroids are very low and *H. azteca* is very sensitive (5th percentile). During a storm event in Vacaville, upstream locations showed most *H. azteca* swimming while downstream locations low to no swimming was observed at 3.6-9.8 toxic units of pyrethroids. Storm sampling in American River (from upstream to downstream) showed decreased swimming and increasing pyrethroid Toxic Units (TUs). Focused TIE approach showed that pyrethroids were most likely responsible for toxicity.

Proposed study: monitor four bay area creeks during three winter rain events, analyze water for pyrethroids, toxicity testing with *H. azteca*, focused TIE on toxic samples, and sampling to provide loading estimates. The study might also include fipronyl analysis. This study is redundant to other studies proposed by SPLWG. This study may be more

appropriate for another workgroup. Do *H. azteca* pick up dissolved pyrethroids or through ligand associated particles? Most likely it is a dissolved exposure.

J. Benthic Index and tool development

Aroon Melwani presented a proposed pilot study for a benthic index and tool development. The proposal will continue refining benthic tools using RMP collected triad data and consists of four tasks:

i. Finalize/validate mesohaline index
ii. Conduct two benthic workshops
iii. Develop Chemistry Score Index for San Francisco Bay
iv. Develop RMP capability to calculate SQO assessment scores

SCCWRP will provide some funding for SQO work. Future needs include funding for an oligohaline index.

K. Molecular TIEs

Steve Bay presented a proposed pilot study for the development of molecular TIEs. The study will try to improve TIE methodology. The project would develop a molecular stressor identification method based on gene expression in amphipods and then would evaluate the method. The project would help us understand sediment toxicity causes with greater relevance and accuracy. Currently, 63% of the Bay shows evidence of impact due to sediment toxicity. Steve Bay commented that we need to look to the animal to understand toxicity. The contaminant will trigger a molecular response in the animal and the mode of action will be specific to a contaminant group. This allows for identification of the chemical that is triggering the response. The project will also measure changes in the RNA relative to a control and see distinctive pattern in response. Project would build the microarray and then test the array (EEPS funding requested). The project will coordinate with existing UC-Davis Granite Canyon work and use their spiked sediments. Sort out fractionation results and organics identification. The project should consider using species that have genetic similarity to avoid inter species variability. The project will need to calibrate microarray with copper, zinc, ammonia, and 3 to 4 organics and determine their signatures. Then test the array with contaminants important to the RMP. EEWG could have a role in identifying the important chemicals. Maybe the toxicity workgroup could be involved in the decision making. The results will be semi quantitative – identification of genes via techniques and software can provide 90% accuracy. Can you use the test to gauge effects not just exposure? Identification of effects would be a next step.

L. Closed Session

The workgroup members asked what the criteria were for decision making. Criteria should include a clear link to management questions and projects need to be technically sound. Studies should be ranked high, medium, or low. Questions: Animal behavior is not considered regulatory – would the Regional Board use this information in regulatory decisions? The Regional Board is not sure how this information would be used. We would first need to determine if an effect is there. Molecular TIEs need to be closely

coordinated with UC-Davis work. If EEPS is only funding for the TIE work – then the priority would drop to the end. Here is a summary of work group member comments:

1. Don Weston
   Regarding the tern proposal and given the error with mercury egg estimation from feathers – there would need to be a dramatic effect on survival in order to see the effect. Supports the Molecular TIE study – could this fit under the work slated for 2010 under sediment toxicity? Low ranking for the following projects: clapper rail, benthos index (proposals seem redundant with limited growth), copper in salmonids, and seals.
2. Arleen Feng
   Priority pollutants in the Municipal Regional Permit would be given top priority (e.g., copper). Believe in continuing work on the sediment triad. BASMAA tied to fees relating to permits and behavior studies go well beyond the scope of the permits.
3. Karen Tabserski
   PBDE studies rank high for the Regional Board. Copper and SQO development are also very important. Molecular TIEs proposals should be funded out of the sediment toxicity workgroup. Toxicity in creeks is an important finding but might not need a study in addition to what is being proposed under the MRP. More information on the clapper rails would be good. The mercury tern work is not seen as important. The seal project would be the lowest priority.
4. Mike Kellog
   Copper and PBDE work are low priority. Molecular TIE work is beneficial. He was interested in seeing a reduced scope for urban creeks.
5. Michael Fry
   SQO assessment seems muddled but seems to be high priority. Copper in salmon investigation is important. PBDE thresholds – there are still questions on using common terns as surrogate for San Francisco Bay terns. Clapper rail is not a good species for future studies therefore low ranking. Urban creeks use a novel approach but still is low priority. Molecular TIEs rank the highest and the tern study the lowest.
6. Steve Weisberg
   Steve liked all proposals. He would like to use three classes to rank the proposals: 1) projects that help interpret existing data will rank highest, 2) projects that look for new classes of chemicals that aren't currently being measured (will rank low), and 3) projects that look at chemicals in the RMP but new modes of effects (will rank lowest).

M. Next Steps

Time ran out before final decisions could be made. Ms. Sedlak will put together a matrix with all of the projects so that workgroup members can list their priority projects.