

RMP Exposure and Effects Workgroup Meeting
May 24th, 2007
Meeting Minutes

Attendees:

Michael Fry, American Bird Conservancy
Harry Ohlendorf, CH2MHill
Daniel Schlenk, UC-Riverside
Karen Taberski, SFRWQCB
Steve Weisberg, SCCWRP

Josh Ackerman, USGS
Collin Eagles-Smith, USFWS
Kevin Kelley, CSU LB

Mike Connor, SFEI
Jay Davis, SFEI
Ben Greenfield, SFEI
Letitia Grenier, SFEI
Katie Harrold, SFEI
Susan Klosterhaus, SFEI
Meg Sedlak, SFEI

By telephone:
John Incardona, NOAA

A. Introductions and Review of Agenda

Meg Sedlak presented an overview of goals for the meeting. EEPS is funded through 2008 at \$200,000 per year. The goals of the meeting were to provide an update of on-going 2007 activities and review pilot and special study proposals for 2008. Approximately \$110,000 is available for funding; \$51,000 has been allocated for small fish, \$35,000 has been allocated for the EEPS report, and \$5,000 for a review panel.

Meg Sedlak presented an overview of the redesigned Status and Trends sampling plan. The TRC approved the incorporation of cormorants, terns, and small fish into Status and Trends.

Meg Sedlak updated the group on Robert Spies' work. He has sent out tissue samples for analysis and expects results shortly. He will send a revised report to the EEPS workgroup in June or July.

Meg Sedlak updated the group on the benthic work being conducted by Bruce Thompson and Sarah Lowe with SCCWRP. SCCWRP has funded SFEI (Bruce and Sarah) to coordinate sampling at approximately 100 sites in the North Bay and Delta. These sites will be sampled for benthos (DWR), sediment chemistry (SFEI) and sediment toxicity (SFEI), providing

information to conduct the sediment triad. Bruce Thompson will present the results of this work to the group at the Fall meeting. Meg Sedlak mentioned that the TRC decided not to incorporate benthos into Status and Trends (S&T) at this time.

Karen Taberski clarified the TRC decision on future benthic work. She stated that the TRC decided to postpone the incorporation of benthos into S&T pending the results of SCCWRP's on-going study. Steve Weisberg indicated that sediment quality will shortly be an extremely important parameter used by the state of California and that it is important that the RMP not be caught unprepared for this assessment.

B. Update on 2007 EEPS Project: Mercury in Terns

Collin Eagles-Smith and Josh Ackerman presented a brief overview of their project. They are evaluating mercury in Forster's Terns to determine egg toxicity thresholds for nest abandonment, hatchability, and chick survival. Water birds are a sensitive endpoint for mercury toxicity. Effects include central nervous system effects such as altered behavior and impaired vision, hearing, and motor skills; endocrine effects; embryo death; embryo deformities; and chick mortality.

Collin Eagles-Smith and Josh Ackerman updated the group on the current status of the study. The Forster's Terns have arrived in the Bay and have begun nesting in the South Bay breeding grounds colonies; chicks are expected to begin hatching in four weeks. Monitoring is being conducted at five colonies. Crews are currently out in the field collecting eggs.

Colin Eagles-Smith and Josh Ackerman presented the methods and preliminary results of a micro-sampling pilot study within the CalFED study. Instead of measuring mercury in one egg and following the success of other eggs in the nest as a surrogate, this study involves taking a small sample, approximately 200-300 μ L, of albumin from an egg and then following the fate of an individual. This study allows scientists to link the mercury concentration and success of an individual egg, which is superior to traditional methods because of variation in mercury concentrations within a clutch. The study is being conducted on avocet and stilt eggs and, to date, there is no difference between the success of sampled and non-sampled eggs. The study has established a strong relationship between albumin and whole egg mercury concentrations.

The concentration of mercury in the birds follows a U-shaped trend over time. The highest concentration is after hatching, concentrations decrease as mercury is "diluted" by growth and depurated to feathers prior to fledging; once the chicks fledge and feather growth decreases, mercury concentrations increase in the birds. There is no difference between the concentration of mercury in newly hatched dead and live avocets but in stilts the concentration is significantly higher in dead than live newly hatched chicks. The data will be published shortly in *Ecotoxicology*.

Jay Davis, Colin Eagles-Smith, and Josh Ackerman discussed the practicalities of continuing this research as part of the RMP. Jay Davis indicated that the expected budget is approximately \$60,000 every three years, similar to the cormorant work, and covers six sites

and analysis of mercury and selenium. Because of the large site effects, Colin Eagles-Smith and Josh Ackerman recommended sampling at least five sites and 15 eggs per site to be analyzed individually. It was suggested that the relationship between whole-egg and albumin selenium concentrations should be investigated to determine the practicality of continuing the micro-sampling methodology. Michael Fry indicated that he had a former graduate student who had conducted research in this area which suggested that there was a poor correlation. Colin Eagles-Smith indicated that he has seen strong R^2 values in the literature between whole-egg and albumin selenium values.

C. Update on 2007 EEPS Project: EDCs in Shiner Surfperch and Pacific Staghorn Sculpin

Kevin Kelley presented his work to-date on endocrine disruption effects in wild fish (shiner surfperch (*Cymatogaster aggregata*) and Pacific staghorn sculpin (*Leptocottus armatus*)) emphasizing assessment of endocrine systems regulating stress responses, growth, repair, thyroid, and reproduction. Endocrine systems are sensitive, responsive, and reflective of stressors. Kevin Kelley indicated that his group is also looking at contaminants in individual fish livers in an attempt to correlate between different kinds of endocrine disruption and specific contaminants.

The hypothalamo-pituitary-interrenal axis (HPI axis) releases cortisol in response to stress. Kevin Kelley found that both shiner surfperch and pacific staghorn sculpin from Oakland Inner Harbor and San Pablo Bay did not produce normal responses to stress. Concentrations of cortisol in stressed shiner surfperch were Redwood City = Berkeley Waterfront > San Pablo Bay = Oakland Inner Harbor. Concentrations of cortisol in stressed pacific staghorn sculpin were Redwood City = Berkeley Waterfront > San Pablo Bay > Oakland Inner Harbor. The HPI axis is somehow impaired; however, there are multiple points where the axis could be disrupted. Literature suggests that interrenal tissues may be the point of disruption and that PCBs have been implicated in the disruption of stress response in fish.

The thyroid endocrine system and hypothalamo-pituitary-thyroid axis (HPT axis) can also be disrupted. Two of the end products of the axis are 3,5,3',5'-tetraiodothyronine (thyroxine) (T3) and 3,5,3'-triiodothyronine (T4). Concentrations of T4 in shiner surfperch were lowest at Oakland Inner Harbor and the same at San Pablo Bay, Berkeley Waterfront, Redwood City, and Bodega Bay. Concentrations of T4 in pacific staghorn sculpin were Tomales Bay > Redwood City > Oakland Inner Harbor = Berkeley Waterfront > San Pablo Bay.

The results of the cortisol, T3, and T4 concentrations suggest that there may be regional impacts that are affecting the fish. Pacific staghorn sculpin have high site fidelity, with some seasonal movement, and shiner surfperch also have high site fidelity. Ben Greenfield indicated that there are stable isotope data suggesting that shiner surfperch stay in a fixed location.

It was suggested that PCB data in sediment for the areas studied would be useful. Kevin Kelley indicated that the individual liver analyses should be useful in a similar manner, but will provide more specific data. It was pointed out that there are many potential endocrine

disruptors, not just PCBs. PBDEs have been shown to decrease T4, but not T3, in mammals and fish.

Kevin Kelley presented other on-going work in his group and future plans. Bodega Bay, Richmond, San Leandro, and a site south of the Dumbarton Bridge will be added to the cortisol and thyroid studies for 2007. The Dumbarton Bridge site may be influenced by municipal discharges, particularly if the samples are collected in the summer. On-going and future plans include interrenal histology work to be done by a colleague at Northern Arizona University, hepatic contaminants correlation, ACTH-challenge with Oakland and Tomales Bay fish, cortisone measurements, ectoparasitic infestation assessment, and further assessment of the growth endocrine system.

Karen Taberski noted that separating stress effects caused by parasites from stress caused by other factors or impairment of the HPI axis would be difficult and raised the possibility that other stressors could make fish more susceptible to parasites. Kevin Kelley indicated that because there is a delay in the release of cortisol to the blood stream after a stress event, it would be possible to determine basal concentrations of cortisol. This may be useful in distinguishing between chronic stress and impairment of the HPI axis. Animals with impaired stress response are often observed to have high basal levels of cortisol relative to normal animals; but, when stressed their cortisol levels increase much less than those of animals with normal stress responses, resulting in lower cortisol concentrations in chronically stressed animals than normal animals when stressed.

Susan Klosterhaus suggested looking at concentrations of PBDE hydroxylated metabolites that mimic thyroid hormone structures.

D. Update on Avian PBDE Effects

Letitia Grenier presented an update of PBDEs egg injection research being conducted by Barnett Rattner and Moira McKernan, USGS-Patuxent Wildlife Research Center. They are working with kestrel, mallard, and chicken eggs. Letitia Grenier also presented a comparison to concentrations in Bay area eggs (Adelsbach *et al.*, 2002, State of the Estuary) and effects concentrations from the Patuxent research. The concentrations found in some of the Bay species fall within the range of concentrations for which effects have been observed. Because the estimated concentrations of Patuxent eggs assume that all the injected material is incorporated, the concentrations are likely overestimates. Thus, it is likely that more of the Bay species' eggs have concentrations of PBDEs within the effects range from Patuxent.

Jay Davis indicated that a feeding study would be useful for comparison of maternally derived and injected PBDEs. Letitia Grenier noted that there is an on-going kestrels feeding study in Canada.

Karen Taberski suggested that an endpoint other than hatching success might be informative. Letitia Grenier indicated that they are looking at thyroid impacts, but that there are no results yet.

Collin Eagles-Smith indicated that in general, at Bay sites, areas that are contaminated with mercury are low in organics and vice versa. This means that in general, there should be little effects overlap.

E. Update on Small Fish Project

Ben Greenfield presented an update on the Small Fish Project. Two new sampling points have been added, Point Isabel and Candlestick Point, and the Napa River site has been dropped due to limited capture success. Through partnerships with IEP and USFWS, opportunistic samples are also included.

Preliminary results from 2006 indicate that in pelagic fish concentrations of mercury are greater in Mississippi silversides than topsmelt, anchovy, and herring. In benthic fish concentrations of mercury are greater in arrow and cheekspot gobies than bay gobies. Spatial patterns indicate that Mississippi silverside mercury concentrations were elevated in South Bay in 2005 and at Point Isabel and Berkeley in 2006; topsmelt mercury concentrations were high at Alviso and Eden Landing in 2005 and at Point Isabel, Richardson Bay, and South Bay in 2006.

The conceptual model that is being used is that Bay margins, where fish with higher concentrations of mercury are found, are closer to sources of methylation and that Bay open waters, where fish with lower concentrations of mercury are found, are further from sources of methylation and that hydraulic mixing provides some dilution.

Fred Hetzel and Ben Greenfield are conducting a pilot study investigating methyl mercury concentrations in sediment, fish, and water around Point Isabel. This study should inform questions about how localized hot spots are and how impacted near shore areas are. The goals of the project are to investigate if the Point Isabel effect is localized to within the wetland or representative of this portion of the Bay and to help distinguish wetland effect from other factors.

Ben Greenspan presented the plans for the study in 2007, which will generally follow the same sample design. New elements include trends analysis, analysis of organics (PCBs, PBDEs, legacy pesticides) in 6 composite samples, and the Point Isabel pilot study.

The study may need to change labs which would result in ~\$10,000 cost increase or require much smaller sample sizes. The panel approved increasing the cost of the small fish project to \$50,000 (\$10,000 more than what was originally budgeted for 2008).

F. Plans for 2008

Meg Sedlak presented a brief overview of already allocated and available money. \$110,000 is currently available for 2008, which could be adjusted based on recommendations regarding the management report. Ms. Sedlak indicated that in part the funding for next year would be a function of the write-up for the 2008 report. She stated that at present, she envisioned a short summary report explaining the results of the pilot study (e.g., which

indicators had been recommended for incorporation into S&T). The group concurred and emphasized the importance of the report being a concise summary of the success of the program.

G. Potential Studies for 2008

Studies for 2008 were outlined by the presenters and the panel was given an opportunity to question the presenters.

Kevin Kelley presented a pilot study to investigate the site specific variation in thyroid disruption in fish. The study would characterize the thyroid endocrine system of Pacific staghorn sculpin and shiner surfperch at sites with different contaminants including PCBs, DDT, and WWTP effluent dominated, to determine the association of thyroid dysfunction with the hepatic accumulation of environmental contaminants, and to assess the function of the thyroid gland.

Collin Eagles-Smith presented a pilot study building on the mercury work being conducted in Forster's terns. He proposed looking at selenium and mercury together and assessing their effects on reproduction in an individual egg using micro-sampling. The proposal also includes assessing intra-clutch variability in mercury and selenium concentrations and investigating the applicability of sibling egg analysis for mercury and selenium effects studies.

John Incardona presented a pilot study of the effects of PAH-contaminated sediment on the early life stages of benthic fish. The proposal involves determining the primary pathways of early life history stage toxicity for PAHs representative of San Francisco Bay sediments and determining the threshold for these effects in sediment-exposed larvae of native flatfish such as California halibut (*Paralichthys californicus*) and English sole (*Pleuronectes vetulus*).

Letitia Grenier presented a proposal to study the variability and bioaccumulation of methyl mercury in marshes in Suisun Bay and Northern San Francisco Bay. The study would investigate the relationship between methyl mercury in the food web and marsh elevation. This study would work in concert with a South Bay Salt Ponds study that is characterizing 30 marshes south of San Mateo Bridge in 2008.

Kevin Kelley presented a proposal to develop phenotypic biomarkers in impacted fish. This study would involve comparing the complete set of expressed proteins in fish from clean and impacted sites.

Letitia Grenier presented a proposal to study in collaboration with an on-going USGS study. The study would use blood and feather samples to develop non-invasive indicators of California clapper rail mercury exposure for future use and quantify sources of mercury in the rail diet by prey type and habitat type (slough, low marsh, marsh plain).

Meg Sedlak indicated that Bob Spies had also submitted a study idea on genomics but that unfortunately neither he nor his collaborators would be available for the day's meeting.

H. Plans for 2009 and Beyond

Jay Davis presented an outline of the five-year plan for the exposure and effects workgroup. The pilot study will be transitioning to a new role as a permanent part of the RMP overseeing pilot studies on exposure and effects and the incorporation and continued oversight of exposure and effects studies in Status and Trends.

I. Panel Recommendations for Pilot and Special Studies

The panel recommended that the studies on mercury in terns (Collin Eagles-Smith and Josh Ackerman), PAH-contaminated sediment and benthic fish (John Incardona), and thyroid disruption in fish (Kevin Kelley) be sent on to the TRC with strong endorsement.