CBDA Project Review Panel

Summary Project Evaluations

CALFED CBDA Project Workshop

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Sacramento, CA

The Review Panel

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Acknowledgments

Thanks to..

- Bay Delta Program (CBDA)
- Donna Podger
- Allen Barnes
- The investigators and presenters
- Attending managers and public

Outline

- General comments
- Project-level comments
- Program-level comments

General Comments

Overall perspective:

- Large body of excellent work has been presented by the scientific teams
- Work is relevant to management issues concerning Hg in Bay-Delta system and tributaries, and all projects are addressing core components of the Mercury Strategy.
- There have been many important advances in past 3-5 years.
- Scientific teams have a demonstrated commitment to work with managers

Contract #S-03-ER-020

Van Buuren Consulting, LLC

Programmatic Quality Assurance and Quality Control for CBDA Mercury Research and Monitoring Projects

What results of value have been produced?

- Inter-lab comparisons for measurements of Total Mercury (THg) in freshwater and Methyl Mercury (MeHg) in sediment have been carried out, and the results have been evaluated and communicated.

- These comparisons are essential for both individual projects, to verify accuracy, and for program-level syntheses of results from the individual projects.

Gaps in current study design?

- For intercomparison samples, need to include water samples that contain a greater range of salinity, DOC, Hg concentrations in water for THg

- Need to add intercomparison samples for MeHg in water, THg in sediments and fish, and THg and MeHg in invertebrates (these are in fact planned for the future)

- Only 4 projects currently participate

Recommendations:

- For inter-laboratory comparisons, labs should analyze samples and report results within a stated time limit, e.g., 30 days.

- Contractor has indicated that more transparency is needed. This refers to the provision of sufficient raw data and supplemental information that would allow a third party to evaluate the path to the final results.

Integration with other projects?

- Yes. This activity is essential for integration of projects with each other.
- The Panel commends the project leader for working constructively with the labs

Other comments?

- Excellent presentation with clear reasons for the need for quality assurance.

- Mandate could be expanded to include all Hg projects in the Ecosystem Restoration Program, and to move towards a program of quality assurance (Q/A) management, rather than be limited to Q/A oversight.

Project #ERP-02-P40

Investigators: M. Marvin-DiPasquale, R. Stewart, N.S. Fisher, P. Pickhardt, R.P. Mason, A. Heyes, L. Windham-Meyer

Project Title: Evaluation of Mercury Transformations and Trophic Transfer in the San Francisco Bay/Delta: Identifying Critical Processes for the Ecosystem Restoration Program

Is the project consistent with the Mercury Strategy?

Yes, project is a model for articulating consistency with the Mercury Strategy. It specifically addresses aspects of:

- **Core Component 1:** Quantification and evaluation of mercury and methyl mercury sources
- **Core Component 3:** Quantification of effects of ecosystem restoration on methyl mercury exposure
- **Core Component 5:** Assessment of ecological risk
- **Core Component 6:** Identification and testing of potential management approaches for reducing methyl mercury contamination

Are project results used to test clearly stated hypotheses?

- Yes.
- Results are related to the stated hypotheses, and are organized and presented clearly.
- Specific habitat characteristics of Consumnes River and Frank's Tract not explicitly invoked in stated hypotheses, but do become apparent in the examination of the more general hypotheses.

Are the hypotheses related to restoration and ecosystem management?

- Yes.
- They provide mechanistic information that helps predict the mercury methylation potential of different habitats by identifying governing processes.
- Differences between the study sites (Consumnes River and Frank's Tract) were examined with a mechanistic approach.
- Examination of relative importance of methyl mercury production and food web dynamics showed that it is likely most fruitful to address conditions that affect methyl mercury production

Could steps be taken to enhance project to support hypothesis testing?

- The limits on the use of ‘reactive’ mercury measurements to estimate bioavailable pool should be evaluated.
- Mercury methylation and demethylation rate data as predictors of methylmercury concentrations should be explored further using a simple model.
- Consider biodilution and growth dilution as explanatory variables.
- Finer scale exploration of spatial variability in biogeochemistry of emergent marsh systems should be considered.

What results of value have been produced?

- Methyl mercury production controls methyl mercury concentrations in upper trophic levels.
- Food web uptake and structure shown to be not as important as expected.
- Decomposition experiments reveal an important internal mercury cycle.
- Dataset sheds light on the controls on differences between methyl mercury in biota in central delta and tributaries.

Does project advance the understanding of factors in the Bay-Delta system that affect MeHg levels?

- Yes
- Importance of internal methyl mercury production in the Consumnes River and and Frank's Tract systems is clearly shown.

Are the limitations of the results clearly presented?

- The project clearly identifies when there is sufficient and insufficient data to test hypotheses.
- Vast majority of situations where data is insufficient are to be addressed in upcoming work.

Gaps in current study design?

- None.

Integration with other projects?

- The MeHg production information should be integrated into a program level mass balance exercise, to see if source strengths from production and inflows can explain observations in the delta
- Process level data should be spatially overlaid with biosentinel/fish monitoring data (Davis et al)
- Bergamaschi et al. DOM-Hg studies could be coupled with ‘reactive’ mercury measurements to explore the “availability” of mineral-derived mercury.

Other comments?

- An excellent comprehensive project, report and presentation.

Project #2000-G01

Project Coordinator: Brian Bergamaschi

Project Researchers: Brian Bergamaschi, Jacob Fleck, Bryan Downing, David Schoellhamer, Megan Lionberger, Emmanuel Boss, George Aiken, Roger Fujii

Project Collaborators: Mark Stephenson, Kenneth Coale, Gary Gill, Chris Foe; Mark Marvin-DiPasquale, Robin Stewart, Nicholas S. Fisher, and Robert P. Mason

Project Title: Mercury Release from Delta Wetlands: facilitation and fluxes; an amendment to existing CALFED Projects #2000-G01

Is the project consistent with the Mercury Strategy?

- Yes.
- **Core Component 1:** Quantification and evaluation of mercury and methylmercury sources is addressed by project Objective 1.
- **Core Component 3:** Quantification of effects of ecosystem restoration on methylmercury exposure is addressed by project Objective 2.

Are project results used to test clearly stated hypotheses?

- Yes.
- Three clear hypotheses are stated that focus the experimental efforts.
- Experiments and results to date directly test the hypotheses stated in the project report.
- Some experiments are incomplete but it is clear that all objectives will be addressed by project completion.

Are the hypotheses related to restoration and ecosystem management?

- Yes.
- Addressing importance of the tidal timescale variability in methyl mercury concentrations is critical to design of monitoring programs and also illuminates possible processes.
- Estimating net methyl mercury flux to/from one of the few tidal marshes in the Delta has important management implications for these systems.
- Dissolved Organic Matter - Mercury hypotheses are critical to linking the transfer of Hg from the solid mineral phase to the water column.

Could steps be taken to enhance project to support hypothesis testing?

- Could a link be made between solubilization and bioavailability of mercury(II) for methylation?
- Which other tidal marsh systems will be examined (e.g. Little Break or Decker Island) to evaluate transferability of the results from the Brown's Island marsh?

What results of value have been produced?

- Tidal timescale variability (e.g. Report Fig. 3&4) provides novel, valuable insights with clear implications for sampling programs.
- Correlation between continuous ancillary data (which are more readily obtainable than continuous mercury data) and some mercury measurements is promising
  - CDOM with filtered methyl mercury
  - TSS and unfiltered total mercury
- Demonstration of the importance of DOM-Hg ratios in determining binding constants is a fundamental contribution.
- The demonstration that DOM that is rich in aromatic carbon has a greater effectiveness in dissolving cinnabar dissolution is also a fundamental contribution.

Does project advance the understanding of factors in the Bay-Delta system that affect MeHg levels?

- The temporal dynamics of contributions of dissolved methyl mercury from a tidal marsh to the Delta have been estimated.
- The understanding of the solubilization of mineral-derived mercury is a crucial link in understanding the relationship (if any) between the legacy mercury from mining operations and the methyl mercury in organisms in the Bay-Delta system.

Are the limitations of the results clearly presented?

- Complications of initial Browns Island mass balance determinations are well documented.
- Particulate methyl mercury relationship with high resolution ancillary data not discussed.
- The degree to which Browns Island is representative of tidal marshes in the Delta is not demonstrated.
- No discussion of how the accuracy of the binding constant method was determined (CLE-SPE).

Gaps in current study design?

- None

Integration with other projects?

- Many project collaborators are indicated, but their role is unclear.
- Cooperation with Stephenson et al. on high resolution sampling/ measurements is obvious.
- Collaboration with Marvin-DiPasquale et al. on the question of the bioavailability of the DOM-mercury complexes using 'reactive' mercury measurements.

Other comments?

- Presentation and report are concise and clear.

Project #ERP-02-C06-A

Investigators: Mark Stephenson, Dr. Chris Foe, Dr. Gary A. Gill, Dr. Kenneth H. Coale

Project Title: Transport, Cycling, and Fate of Mercury and Monomethyl Mercury in the San Francisco Delta and Tributaries: An Integrated Mass Balance Assessment Approach

Is the project consistent with the Mercury Strategy?

- The task descriptions are consistent with objectives in Mercury Strategy including
  - Core Component 1: Quantification and Evaluation of Mercury and Methylmercury Sources
  - Core Component 6: Identification and Testing of Potential Management Approaches for Reducing Methylmercury Contamination

Are project results used to address clearly stated hypotheses/goals?

- The project addresses clearly stated goals
- Focused goal of developing a complete mass balance of the Delta with all tasks directed towards this goal:
  - River fluxes
  - Atmospheric deposition
  - Benthic fluxes
  - Photodemethylation
  - Air-water exchange
- Project specific hypotheses that can be supported or refuted by the research are not stated explicitly in the annual report.

Are the hypotheses/goals related to restoration and ecosystem management?

- Yes.
- Improving understanding of Hg sources and sinks is highly relevant to restoration and ecosystem management
  - Which sources to remediate
  - helps guide where to put effort for most value

Could steps be taken to enhance projects to support hypothesis testing?

- Continue to test the hypothesis that MeHg is transported conservatively in the Sacramento River
  - Study processes that could eliminate or produce MeHg as water travels downstream
- More detailed assessment of loss of MeHg and THg mass in the Stockton Deep Ship Channel would be useful
- Project should demonstrate that monthly and bimonthly sampling regimes of MeHg and THg concentrations are adequate
- Mass balance should consider additional terms (see later slides)

What results of value have been produced? Does project advance the understanding of factors in the Bay-Delta system that affect MeHg levels?

- A large portion of the MeHg load to the Delta is believed to be contributed by Mud Slough, which accounts for only 10% of the total Delta inflow during the non-irrigation season
- Connate groundwater may be a substantial source of MeHg in some regions
- Photodemethylation is an important sink term in the Delta
- A time series water sampler has been created
- A strong tidal signal of MeHg was noted at Mandeville Cut.

What results of value have been produced? (cont.)

- The study suggested a net efflux of gaseous Hg species
- Twitchell Island study showed different rates of methylation between two similar wetlands
  - This provides an opportunity for process level study
- Time series sampling suggested highly variable fluxes among wetlands in Suisun Marsh with a net influx or neutral flux to some wetlands, contrary to common expectations

Are the limitations of the results clearly presented?

- Uncertainty associated with mass balance components was not shown

Gaps in current study design?

- Sampling of MeHg, in addition to currently sampled THg, during high flow events.
- Sole use of unfiltered samples precludes interpretation of the particulate versus dissolved load.
- Bedload transport of total mercury is not considered?

Integration with other projects?

- This is an ambitious undertaking, and the groups is commended for the broad scope of their efforts. Because so much information is required, this project should consider utilizing contributions of other studies to augment, or to reduce the effort required for, some of the components of the existing mass balance effort.
  - Include biological compartments for MeHg
  - Utilize estimates of local production of MeHg from the Marvin-DiPasquale group
  - Examine potential for water column methylation
  - Consider settling of HgT and MeHg in water column mass balances
- The sampling strategy and temporal analysis techniques of the Alpers study, including sampling of flow events may be useful to this study
- The autosamplers used in the Stephenson study may be useful in other projects to capture tidal time scale variability in MeHg
- Techniques to correlate MeHg to other observations from the Bergamaschi study may be useful.

Other comments?

- Map of sampling sites in river systems would be very helpful.
- The annual report provided many conclusions but limited data. This may be due to concise nature of report requested.
  - e.g., provide flow and concentration for each site used in the mass balance
- What was the time interval used for the mass balance?
  - It appears that different components of the mass balance (Figure 5) are based upon measurements during different periods

Project #ERP 02D-P67

Investigators: Jay Davis, Jennifer Hunt, Letitia Grenier, Mark Stephenson, Gary Ichikawa, Darrel Slotton, Shaun Ayers, Robert Brodberg, Mary Gassel, Alyce Ujihara, and Jessica Kaslow

Project Title: A Pilot Program for Monitoring, Stakeholder Involvement, and Risk Communication relating to Mercury in Fish in the Bay-Delta Watershed

Is the project consistent with the Mercury Strategy?

This project addresses multiple objectives listed under:

- Core component 3 (Quantification of Effects of Ecosystem Restoration on Methylmercury Exposure) and
- Core component 4 (Monitoring of Mercury in Fish, Health-Risk Assessment, and Risk Communication)

Are project results used to test clearly stated hypotheses/goals?

- Data (when collected) will directly address the goals of the project.

Are the hypotheses related to restoration and ecosystem management?

- Input from stakeholders and information from analyses of sport fish will provide a foundation for risk assessment and risk communication concerning human consumption of fish from the ecosystem.
- Information from analyses of biosentinel organisms will be useful for assessing the effect of ecosystem restoration activities on methyl mercury contamination of aquatic food webs.
- Methyl mercury concentrations in aquatic biosentinel organisms can serve as a useful "performance measure" for management and restoration.

Could steps be taken to enhance project to support hypothesis testing?

- Specific hypotheses should be developed for the biosentinel component, which focuses largely on assessing the effects of ecosystem restoration on the bioaccumulation of methyl mercury.
- Formulate hypotheses pertaining to effects of restoration projects on spatial and temporal patterns in methyl mercury concentrations in biosentinel organisms.
- Is it possible to formulate and test hypotheses pertaining to the types or characteristics of restoration projects?
- Also evaluate the extent to which concentrations of methyl mercury in biosentinel organisms can be used as an indicator of methyl mercury in sport fishes.

What results of value have been produced?

- Efforts in 2005 were appropriately devoted to detailed project planning, stakeholder input, development and peer review of a sampling plan and QA materials, and to first-year sampling.
- Project investigators are expected to report the findings from analyses of several hundred samples of sport fish and biosentinel organisms at the next annual review (2006). Results of those analyses will be directly applicable to risk analysis, risk communication, and evaluation of restoration effects.

Does project advance the understanding of factors in the Bay-Delta system that affect MeHg levels?

- Indirectly. The project will provide an index of MeHg contamination of aquatic foodwebs.
- Spatial and temporal components of biosentinel work will be useful for assessing effects of restoration activities on the abundance of methylmercury and its entry into aquatic food webs supporting sport fish and wildlife.

Are the limitations of the results clearly presented?

Recommendations:

- Provide a detailed description of the approaches used and the information obtained in assessing fishing activity, because fishing activity was one of several variables applied to selection of locations and fish species during development of the sampling plan.

- Post such information on the project web site

Gaps in current study design?

- None

Integration with other projects?

- Communication is especially important for this project
- Successful application of project findings will rely strongly on multiple forms of communication with a diverse array of end users (public, environmental health professionals, ecosystem managers, scientists, others).
- Communication pathways and approaches pertaining to risk assessment and risk communication seem to be fairly well defined.
- A formal pathway for communication of project activities and results to ecosystem managers should be developed and instituted, to facilitate application of project findings to adaptive management.

Other comments

- The project investigators are commended for their focused efforts in detailed planning, obtaining stake-holder input and external review, and for completing first-year sampling within a limited time frame.

Project #ERP-02D-P62

Investigators: Donald Yee, Joshua Collins, Letitia Grenier, San Francisco Estuary Institute* John Takekawa, Steven Schwarzbach, USGS BRD, Mark Marvin-DiPasquale, USGS Menlo Park, David Krabbenhoft, USGS Middleton, WI. Jules Evens, Avocet Research Associates

Project Title: Mercury and Methylmercury Processes in North San Francisco Bay Tidal Wetland Ecosystems

Is the project consistent with the Mercury Strategy?

- The project goals are consistent with objectives in Mercury Strategy, including
  - Core Component 1: Quantification and evaluation of mercury and methylmercury sources
  - Core Component 5: Assessment of ecological risk

Are project results used to test clearly stated hypotheses/goals?

- The "current working hypotheses" stated in the report are general and not project specific
- The goals of the research are stated clearly but are also quite general
- The research proposal did state hypotheses and the text suggests project specific hypotheses, including
  - MeHg production in tidal wetlands follows predictable spatial and temporal patterns due to the physiographic template of the wetlands
  - Hg in Black Rails is related to surface sediment MeHg concentrations in the rails home range

Are the hypotheses related to restoration and ecosystem management?

- The goals stated in the report are strongly related to restoration and ecosystem management
- Clearly stated, project- specific hypotheses may improve our understanding of the relevance of the project
- Management implications are discussed in project report

Could steps be taken to enhance projects and to support hypothesis testing?

Analysis of temporal variability in MeHg, DOC and other variables may strengthen conclusions:

- Planned work includes consideration of spring-neap variability in MeHg in water and sediment. The project should also consider tidal time scale variability of MeHg in slough water
- A limited number of tidal time scale observations would allow understanding of potential bias due to timing of water column sampling (typically conducted at low water?)
- Observation of rapid changes in sediment and water MeHg concentrations over a scale of hours to days may support the hypothesis of de novo production of MeHg

What results of value have been produced? Does project advance the understanding of factors in the Bay-Delta system that affect MeHg levels?

- Project showed that bioaccumulation in resident bird populations is correlated with sediment MeHg concentrations in their home ranges
- Project results suggest that high marsh conditions in the wetland sites produce more MeHg than slough channels
- Project results suggest that sediment MeHg concentrations in high marsh habitats are determined by in situ biogeochemical processes
- The investigators conclude that total mercury concentration does not explain variability in MeHg in sediments but MeHg is correlated to organic material
- Showed the home ranges of Black Rails
- Linkage of natural history, biogeochemical and ecology in a single project is impressive

Are the limitations of the results clearly presented?

- Several limitations and uncertainties are discussed in the report
- It would be useful to provide a section discussing limitations and uncertainties of the study
- Transferability of results—do findings apply to other marshes?

Gaps in current study design?

- In the report and presentation planned studies and ongoing studies were mentioned that contain several additional components, but these could have been described more completely. We believe (and recommend) that these studies will include the following components that will enhance the project:
  - Further study of within-site variability
  - Stable isotope analyses to understand better the trophic linkages between benthic invertebrates and Black Rails
  - Continuous observations of redox conditions
  - Continuous observations of salinity
  - Continuous observations of water depth

Integration with other projects?

- Are Black Rails included in egg injection studies in the Schwarzbach project?
  - Note--Steve Schwarzbach answered that obtaining the permits required to use Black Rail eggs would be difficult to impossible because the California Black Rail is a state listed threatened species.
- Can the tidal time scale variability observed in the Bergamaschi et al study be used to inform future study design?
- The autosamplers used in the Stephenson study may be useful in this project to capture tidal time scale variability in MeHg

Other comments?

- The initial results of this project are interesting and substantial, and we expect that the project will continue to produce useful findings.
- Sampling methods should be discussed in reports, including compositing of surficial sediment samples
- Several planned extensions of project were discussed in the presentation. A description of these extensions would be useful in the project report

Project #ERP-02-D-C12

Investigators: Steven E. Schwarzbach,Thomas H. Suchanek, Gary H. Heinz, Joshua T. Ackerman1, Collin A. Eagles-Smith3, Terrence L. Adelsbach3, John Y. Takekawa1, A. Keith Miles1, David J. Hoffman2, Susan E. Wainwright-De La Cruz1, Sarah E. Spring1, Mark A. Ricca1, and Thomas C. Maurer3

Project Title: Mercury in Birds of the San Francisco Bay-Delta: Trophic Pathways, Bioaccumulation and Ecotoxicological Risk to Avian Reproduction

Is the project consistent with the Mercury Strategy?

- Yes
- Core Component 5: Assessment of ecological risk
- Core Component 1: Quantification and evaluation of Hg and MeHg sources (from a trophic perspective)

Are project results used to test clearly stated hypotheses/goals?

- Hypotheses not stated as such, rather objectives and tasks are clearly stated.
- Objectives can easily be restated as hypotheses,e.g.,
  - MeHg exposure in different guilds of birds is related to diet
  - Reproductive success is related to Hg levels in chicks;
  - Laboratory determinations of NOAELs will be useful/not useful in predicting the effect of Hg on birds in the wild.

Are the hypotheses related to restoration and ecosystem management?

- Results will provide information on Hg levels in birds and in their habitat that could adversely affect exposed populations
- Results will help to identify circumstances and locations that can contribute to ecological risk.
- Project does not explicitly provide information on approaches to management that would be beneficial, but things may come out in future as Hg pathways are identified.

Could steps be taken to enhance projects to support hypothesis testing?

- No - project is well designed.

What results of value have been produced?

- This is a very high quality study, using state of the art methodology and approaches. Determination of foraging areas using telemetry, and diets, using emetics, is very important because it allows identification of feeding ranges and the sampling of food items actually used by the birds.
- This study has clearly demonstrated toxic effects on birds in the wild at levels of Hg found in the Bay-Delta area. (sure that there are no other co-varying factors that might have cause the slower growth?)
- This study has clearly demonstrated that eggs of different bird species show toxicity to MeHg at different levels, and that extrapolation of mallard results to all birds is not valid.

What results of value have been produced (cont.)?

- Data clearly show that when birds arrive from the north, in the SF Bay area, MeHg levels begin to increase, and continue to increase throughout the winter.
- The ability to follow birds (scoters) back to their breeding areas, after wintering in San Francisco Bay, adds an important dimension to understanding the effects of local MeHg uptake in these birds to their full life cycle. Also, the telemetry gives graphic results that will increase the appreciation of non-birders for the challenges faced by these species.
- Coupled field and laboratory studies demonstrate measurable threshold levels of MeHg contamination that can be used by managers to evaluate whether a location/ecosystem is likely pose a significant risk to birds.

Does project advance the understanding of factors in the Bay-Delta system that affect MeHg levels?

- The spatial survey of MeHg in birds, and their prey found in identified foraging ranges, can reveal habitats where MeHg concentrations are high in the environment. This can be used to focus other research efforts on habitats of concern.
- This has implications for wetland restoration, meaning that the birds will likely feed in one wetland, and the conditions in that wetland will determine their MeHg levels.

Are the limitations of the results clearly presented?

- Statistics were clearly presented on the chick growth data.
- No statistics on egg toxicity experiment.
- Growth of tern chicks: is MeHg high because of slow growth, or is slow growth because of high MeHg.

Gaps in current study design?

- Are there studies being done on PCBs, Se by themselves so their contribution to toxicity in the egg injection studies will be known? Can the interactions be explored more thoroughly?
- To what extent does the presence of Se complicate interpretation of the MeHg dosing results in the egg-injection experiment?

Integration with other projects?

- Steve Schwarzbach and John Takekawa are investigators on the other project involving birds in the Petaluma R. (Yee et al).
- The project was not designed to address factors affecting MeHg production or what determines MeHg in the food items, and so here is a place where this project could interface with projects working on MeHg production and transport.

Other comments?

- This is a terrific study; possibly the best study of its kind.

Project #ERP-02-D-C01-D

Project Chief: Charles N. Alpers, U.S. Geological Survey, California Water Science Center, Sacramento CA **Collaborators:** Ronald C. Antweiler, and Howard E. Taylor, USGS, Boulder, CO Jennifer A. Curtis, Lorraine A. Flint, and Michael P. Hunerlach, USGS, Sacramento, CA John F. DeWild and David P. Krabbenhoft, USGS, Madison, WI Mark C. Marvin-DiPasquale, USGS, Menlo Park, CA Darell G. Slotton and Shaun M. Ayers, Univ. of California, Davis, CA Noah P. Snyder, Boston College, Boston, MA

Project Title: Upper Yuba River Studies Program - Water Quality Studies

Is the project consistent with the Mercury Strategy?

Yes. The project directly addresses the following core components:

(1) Quantification and evaluation of mercury and methylmercury sources

(3) Quantification of effects of ecosystem restoration on methylmercury exposure.

(6) Identification and testing of potential management approaches for reducing methyl mercury contamination.

Are project results used to test clearly stated hypotheses/goals?

- Upper Yuba study was developed with stakeholders including scientists, managers and public
- The study was therefore more driven by goals, objectives and specific questions in support of a project mission statement.
- Goals were clearly stated

Are the hypotheses/goals related to restoration and ecosystem management?

Yes, goals were directly relevant to mission statement for Upper Yuba system:

"Determine if introduction of wild chinook salmon and steelhead to the Yuba River watershed is biologically, environmentally, and socio-economically feasible over the long term."

Could steps be taken to enhance projects to support hypothesis testing?

- Work reported at this workshop has been completed.

What results of value have been produced?

- MeHg in biota in areas impacted by historical gold mining are 4-5X higher than at upstream (not impacted) sites.
- MeHg in biota is not high enough to be considered a risk for acute exposure, but may pose a chronic risk to anadromous fish if they are introduced to the system.
- Single storm events can be very important in Hg transport.
- Detailed sampling revealed hysteresis for flow/Hg concentration relationship.

Does project advance the understanding of factors in the Bay-Delta system that affect MeHg levels?

Yes the project demonstrated:

- that historical gold mining affects fish Hg locally.
- Hg loading is highly variable with time and flow, which has important implications for river sampling design.

Integration with other projects?

Findings regarding event-scale loads should be noted and considered by other projects.

Program Level Scientific Comments

Program-level Comments

The program requires integration across projects. Steps to help move in this direction include:

A mercury coordinator position is crucially needed, as recommended in the Mercury Strategy.

- Help integrate studies
- Ecosystem-scale synthesis (more than the sum of its parts)
- Identify gaps at program level
- Strengthen linkages among project teams and with ecosystem managers

Program-level Comments

- **Recommend teams convene in next 2-6 months to continue efforts to synthesize results, integrate research, and work towards integrated publications. This should be an ongoing and iterative process.**

- **Within the next 6-12 months, the project investigators should develop publication plans, including:**
  - listing tentative manuscript titles
  - identifying roles and responsibilities of contributing authors
  - target refereed journals
  - target dates for completion and submission of manuscripts

Program-level Comments

Other comments:

- Program seems to be moving focus towards *in situ* factors affecting methylation, and this is totally appropriate, but don't forget the potential for point sources to contribute to fish Hg.

- The possible contribution of atmospheric deposition (wetfall and dryfall) as a source of Hg for methylation and bioaccumulation should continue to be considered. This is a small source of HgT, but possibly an important source of bioavailable, inorganic Hg(II)).

Program level Comments

- Possible selenium interactions should be considered
- Develop metadata listings (types, dates, sites of samples and measurements made) for projects and compile for entire program.

Program-level Comments

- Program should enhance efforts to make results transferable to other sites. This requires process-based studies and understanding.

- Address Core Component 6 (identification and testing of potential management approaches for reducing MeHg contamination) by carrying out pilot level experimentation.

Program-level Comments

Modeling

- **Panel recommends considering the use of mechanistic models.**
- **A single mechanistic model of the entire system would likely be too unwieldy, but models for specific processes or components of the Bay-Delta system may have value.**
- **Simple and complex models should be both be considered.**

Program-level Comments

- **Modeling**
  - **Potential uses of mercury models**
    - Develop and test equations to describe mercury cycling processes
    - Encourage integration among projects
    - Inform design of monitoring and applied studies, and identify gaps in field programs
    - Allow improved interpretation and extrapolation of observations
    - Aid in identification of key uncertainties
    - Predict trends in mercury concentration
      - Effects of management actions

Program Level Management Comments

Implications for Restoration and Ecosystem Management

1. Study results clearly demonstrate large spatial and temporal variability, which makes it difficult to generalize from a) studies of specific areas, and b) limited data points.
2. Continuation of biosentinel work is important for describing broad temporal and spatial patterns in MeHg, given the limitations of short term temporal and spatial specific data.
3. Quality assurance efforts are necessary to compare studies from different locations and times which is essential to describing broad scale trends over time and space.

Restoration and Ecosystem Management (Con't)

4. Due to difficulties of measuring MeHg and related processes as well as limited resources and numbers of people with the required expertise, it is important to integrate project specific monitoring with regional and program-level monitoring efforts. Rather then deploy completely new monitoring teams for specific projects, it will be most effective for existing research teams to expand their scope to collect data or provide advice on sampling protocols (with funding from individual projects) for restoration projects.

Restoration and Ecosystem Management (Con't)

5. The reports at this meeting have shown much progress in the identification of specific factors that are correlated with higher rates of methylation activity. This type of information is essential in predicting the likely outcome of future management and restoration activities, and so further work along these lines is encouraged.
6. It would be helpful to managers for researchers to focus on mechanisms that managers can control or are asked to control while still achieving other ecosystem goals. One such mechanism is the frequency, duration, and depth of inundation.

Risk Management

- Biosentinel and sport-fish monitoring are fundamentally important and valuable for bounding potential risk to humans and wildlife.
- Fish monitoring work will be of limited value for reducing human exposure unless it effectively communicated to the general public and particularly the communities that consume large amount of fish.
- Avian risk study will help establish thresholds of concern to guide management decisions

Management of Loads and Sources

Current state of scientific knowledge that is particularly useful for this topic:

- The water in the major rivers (the Sacramento and San Joaquin) that enter the Delta is elevated in inorganic Hg, because tributaries to these rivers drain areas with historic mining disturbances.
- MeHg production and transport from upstream watersheds and MeHg production within the Delta are both important sources of MeHg to the Delta.
- Some habitats in the upstream watershed, and in the Delta, produce more MeHg than others, and biota in local areas with these habitats are higher in MeHg

Management of Loads and Sources (cont'd)

- Mass balance data suggest that MeHg produced in upstream watersheds may be conservatively transported down the rivers to the Delta. An alternative possibility is that MeHg is being degraded and replaced by MeHg produced in the river sediments. This needs to be sorted out more definitively, because the results are important in guiding whether efforts that decrease MeHg production in upper watershed areas (such as Mud Slough) will benefit the major river channels and the Delta.

Management of Loads and Sources (cont'd)

We need to know whether remediation of source sites (e.g.,abandoned mines) will substantially reduce the abundance of MeHg in the rivers and the Delta over time.

- At present, there do not appear to be any studies of remediation efforts that specifically inform this question. However, there are examples of gross mercury contamination, with mercury distributed broadly through the ecosystem (e.g. chlor-alkali facilities), where remediation has effectively reduced fish mercury concentrations, but the potential benefits of remediation in situations specifically relevant to the Bay-Delta system (i.e., related to gold or mercury mines) needs attention.

Management of Loads and Sources (cont'd)

Evidence suggests that manipulation (where practical) of local conditions within the Delta (e.g., particular wetland habitats) that affect methyl mercury production could be an effective management approach in decreasing MeHg sources to biota in the same local areas. This would be most easily achieved in cases where new wetlands are designed and constructed.

However, we don't know if a general lowering of mercury inputs from upstream watersheds would have an even greater effect, or comparatively little effect, on methylation rates in these local areas

Management of Loads and Sources (cont'd)

In the future, the Review Panel recommends more organization of effort, and discussion, by project investigators on the relative effectiveness of the following two categories of remediation approaches:

1. Decreasing loads of inorganic Hg from upstream watersheds to the major rivers and to the Delta.
2. Controlling conditions that contribute to higher rates of MeHg production in local areas of the upstream watersheds and of the Delta.