MERCURY IN DELTA FISH: ESTABLISHING A NETWORK FOR LONG TERM STUDY

Project Information

1. **Proposal Title:**

   MERCURY IN DELTA FISH: ESTABLISHING A NETWORK FOR LONG TERM STUDY

2. **Proposal applicants:**

   Jay Davis, San Francisco Estuary Institute
   Mark Stephenson, San Jose State University Foundation
   Maura Mack, California Department of Health Services
   Darell Slotton, UC Davis

3. **Corresponding Contact Person:**

   Jay Davis
   San Francisco Estuary Institute
   7770 Pardee Lane Oakland, CA 94621
   510 231 9539
   jay@sfei.org

4. **Project Keywords:**

   Bioaccumulation
   Contaminants
   Water Quality Assessment & Monitoring

5. **Type of project:**

   Monitoring

6. **Does the project involve land acquisition, either in fee or through a conservation easement?**

   No

7. **Topic Area**:

   Ecosystem Water and Sediment Quality

8. **Type of applicant:**

   Private non-profit

9. **Location - GIS coordinates:**

Latitude: 38.084

Longitude: -121.527

Datum:

Describe project location using information such as water bodies, river miles, road intersections, landmarks, and size in acres.

The Delta and tributaries as they enter the Delta

10. **Location - Ecozone:**

    8.1 Feather River, 12.1 Vernalis to Merced River, 1.1 North Delta, 1.2 East Delta, 1.3 South Delta, 1.4 Central and West Delta, 11.1 Cosumnes River, 11.2 Mokelumne River

11. **Location - County:**

    Contra Costa, Sacramento, San Joaquin, Solano, Sutter, Yolo

12. **Location - City:**

    Does your project fall within a city jurisdiction?

    No

13. **Location - Tribal Lands:**

    Does your project fall on or adjacent to tribal lands?

    No

14. **Location - Congressional District:**

    Thirteenth

15. **Location:**

    California State Senate District Number: 9

    California Assembly District Number: 16

16. **How many years of funding are you requesting?**

    3

17. **Requested Funds:**
    a) Are your overhead rates different depending on whether funds are state or federal?

       No

       If no, list single overhead rate and total requested funds:

Single Overhead Rate: 153%

Total Requested Funds: 1456531.31

b) Do you have cost share partners already identified?

Yes

If yes, list partners and amount contributed by each:

DHS $60,000

c) Do you have potential cost share partners?

No

d) Are you specifically seeking non-federal cost share funds through this solicitation?

No

If the total non-federal cost share funds requested above does not match the total state funds requested in 17a, please explain the difference:

18. **Is this proposal for next-phase funding of an ongoing project funded by CALFED?**

No

Have you previously received funding from CALFED for other projects not listed above?

Yes

If yes, identify project number(s), title(s) and CALFED program.

ERP-99-N07	**Chronic Toxicity of Environmental Contaminants in Sacramento Splittail: A Biomarker Approach**	**ERP**
ERP-99-B06	**Assessment of the Ecological and Human Health Impacts of Mercury in the Bay-Delta Watershed**	**ERP**

19. **Is this proposal for next-phase funding of an ongoing project funded by CVPIA?**

No

Have you previously received funding from CVPIA for other projects not listed above?

No

20. **Is this proposal for next-phase funding of an ongoing project funded by an entity other than CALFED or CVPIA?**

    No

    Please list suggested reviewers for your proposal. (optional)

Jim Wiener	**University of Wisconsin Lacrosse**	**608 785 6454**	**wiener.jame@uwlax.edu**

21. **Comments:**

Environmental Compliance Checklist

MERCURY IN DELTA FISH: ESTABLISHING A NETWORK FOR LONG TERM STUDY

1. **CEQA or NEPA Compliance**
   a) Will this project require compliance with CEQA?

      No
   b) Will this project require compliance with NEPA?

      No
   c) If neither CEQA or NEPA compliance is required, please explain why compliance is not required for the actions in this proposal.

      This is an environmental monitoring project.

2. **If the project will require CEQA and/or NEPA compliance, identify the lead agency(ies).** *If not applicable, put "None".*

   CEQA Lead Agency:
   NEPA Lead Agency (or co-lead:)
   NEPA Co-Lead Agency (if applicable):

3. **Please check which type of CEQA/NEPA documentation is anticipated.**

   CEQA
   -Categorical Exemption
   -Negative Declaration or Mitigated Negative Declaration
   -EIR
   Xnone

   NEPA
   -Categorical Exclusion
   -Environmental Assessment/FONSI
   -EIS
   Xnone

   If you anticipate relying on either the Categorical Exemption or Categorical Exclusion for this project, please specifically identify the exemption and/or exclusion that you believe covers this project.

4. **CEQA/NEPA Process**
   a) Is the CEQA/NEPA process complete?

      Not Applicable

   b) If the CEQA/NEPA document has been completed, please list document name(s):

5. **Environmental Permitting and Approvals** (*If a permit is not required, leave both Required? and Obtained? check boxes blank.*)

LOCAL PERMITS AND APPROVALS

Conditional use permit

Variance

Subdivision Map Act

Grading Permit

General Plan Amendment

Specific Plan Approval

Rezone

Williamson Act Contract Cancellation

Other

STATE PERMITS AND APPROVALS

Scientific Collecting Permit Required, Obtained

CESA Compliance: 2081

CESA Compliance: NCCP

1601/03

CWA 401 certification

Coastal Development Permit

Reclamation Board Approval

Notification of DPC or BCDC

Other

FEDERAL PERMITS AND APPROVALS

ESA Compliance Section 7 Consultation

ESA Compliance Section 10 Permit

Rivers and Harbors Act

CWA 404

Other

PERMISSION TO ACCESS PROPERTY

Permission to access city, county or other local agency land.
Agency Name:

Permission to access state land.
Agency Name:

Permission to access federal land.
Agency Name:

Permission to access private land.
Landowner Name:

6. **Comments.**

Land Use Checklist

MERCURY IN DELTA FISH: ESTABLISHING A NETWORK FOR LONG TERM STUDY

1. **Does the project involve land acquisition, either in fee or through a conservation easement?**

   No

2. **Will the applicant require access across public or private property that the applicant does not own to accomplish the activities in the proposal?**

   No

3. **Do the actions in the proposal involve physical changes in the land use?**

   No

   If you answered no to #3, explain what type of actions are involved in the proposal (i.e., research only, planning only).

   Monitoring only

4. **Comments.**

Conflict of Interest Checklist

MERCURY IN DELTA FISH: ESTABLISHING A NETWORK FOR LONG TERM STUDY

Please list below the full names and organizations of all individuals in the following categories:

- Applicants listed in the proposal who wrote the proposal, will be performing the tasks listed in the proposal or who will benefit financially if the proposal is funded.
- Subcontractors listed in the proposal who will perform some tasks listed in the proposal and will benefit financially if the proposal is funded.
- Individuals not listed in the proposal who helped with proposal development, for example by reviewing drafts, or by providing critical suggestions or ideas contained within the proposal.

The information provided on this form will be used to select appropriate and unbiased reviewers for your proposal.

Applicant(s):

Jay Davis, San Francisco Estuary Institute
Mark Stephenson, San Jose State University Foundation
Maura Mack, California Department of Health Services
Darell Slotton, UC Davis

Subcontractor(s):

Are specific subcontractors identified in this proposal? Yes

If yes, please list the name(s) and organization(s):

Dave Kohlhorst	California Department of Fish and Game
Mark Stephenson	San Jose State University Foundation/California Department of Fish and Game
Maura Mack	California Department of Health
Darell Slotton	University of California at Davis
Gary Ichikawa	California Department of Fish and Game

Helped with proposal development:

Are there persons who helped with proposal development?

Yes

If yes, please list the name(s) and organization(s):

Janis Cooke	**Central Valley Regional Water Quality Control Board**

Chris Foe **Central Valley Regional Water Quality Control Board**

Comments:

Budget Summary

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Please provide a detailed budget for each year of requested funds, indicating on the form whether the indirect costs are based on the Federal overhead rate, State overhead rate, or are independent of fund source.

Independent of Fund Source

Year 1												
Task No.	**Task Description**	**Direct Labor Hours**	**Salary *(per year)***	**Benefits *(per year)***	**Travel**	**Supplies & Expendables**	**Services or Consultants**	**Equipment**	**Other Direct Costs**	**Total Direct Costs**	**Indirect Costs**	**Total Cost**
1	Project Management	864	24687.20	4,601.69	1,000.00	0	20,000.00	0	0	50288.89	44,814.94	95103.83
2A	Sampling: DRSFMP	0	0	0	0	0	54,000.00	00	0	54000.0	0	54000.00
2B	Sampling: Non-DRSFMP	0	0	0	0	0	44,109.85	0	0	44109.85	0	44109.85
2C	Sample Processing	0	0	0	0	0	40,208.77	0	0	40208.77	0	40208.77
3A	Sport fish chemical analysis	0	0	0	0	0	76,974.21	0	0	76974.21	0	76974.21
4A	Small fish sampling and chemical analysis	0	0	0	0	0	37,846.00	0	0	37846.0	0	37846.00
5A	Data analysis	320	8822.00	1644.42	0	0	0	0	0	10466.42	16,014.67	26481.09
6A	Stakeholder and Public Outreach	80	2398.00	446.99	1,000.00	0	89,971.00	0	0	93815.99	4,353.11	98169.10
		1264	35907.20	6693.10	2000.00	0.00	363109.83	0.00	0.00	407710.13	65182.72	472892.85

Year 2												
Task No.	**Task Description**	**Direct Labor Hours**	**Salary *(per year)***	**Benefits *(per year)***	**Travel**	**Supplies & Expendables**	**Services or Consultants**	**Equipment**	**Other Direct Costs**	**Total Direct Costs**	**Indirect Costs**	**Total Cost**
1	Project Management	864	25921.92	4,831.85	1,000.00	0	20,000.00	0	0	51753.77	47,056.34	98810.11
2A	Sampling: DRSFMP	0	0	0	0	0	54,000.00	0	0	54000.0	0	54000.00
2B	Sampling: Non-DRSFMP	0	0	0	0	0	39,055.64	0	0	39055.64	0	39055.64
2C	Sample Processing	0	0	0	0	0	42,030.21	0	0	42030.21	0	42030.21
3A	Sport fish chemical analysis	0	0	0	0	0	79,260.52	0	0	79260.52	0	79260.52
4A	Small fish sampling and chemical analysis	0	0	0	0	0	39,736.00	0	0	39736.0	0	39736.00
5A	Data Analysis	320	9263.60	1,726.74	0	0	0	0	0	10990.34	16,816.31	27806.65
6A	Stakeholder and Public Outreach	80	2518.00	469.36	1,000.00	0	93,795.00	0	0	97782.36	4,570.95	102353.31
		1264	37703.52	7027.95	2000.00	0.00	367877.37	0.00	0.00	414608.84	68443.60	483052.44

Year 3												
Task No.	**Task Description**	**Direct Labor Hours**	**Salary *(per year)***	**Benefits *(per year)***	**Travel**	**Supplies & Expendables**	**Services or Consultants**	**Equipment**	**Other Direct Costs**	**Total Direct Costs**	**Indirect Costs**	**Total Cost**
1	Project Management	864	27218.04	5,073.44	1,000.00	0	20000	0	0	53291.48	49,409.20	102700.68
2A	Sampling: DRSFMP	0	0	0	0	0	54,000.00	0	0	54000.0	0	54000.00
2B	Sampling: Non-DRSFMP	0	0	0	0	0	40,573.72	0	0	40573.72	0	40573.72
2C	Sample Processing	0	0	0	0	0	43,942.72	0	0	43942.72	0	43942.72
3A	Sport fish chemical analysis	0	0	0	0	0	81,661.14	0	0	81661.14	0	81661.14
4A	Small fish sampling and chemical analysis	0	0	0	0	0	41,734.00	0	0	41734.0	0	41734.00
5A	Data Analysis	320	9727.20	1,813.15	0	0	0	0	0	11540.35	17,657.89	29198.24
6A	Stakeholder and Public Outreach	80	2644.00	492.84	1,000.00	0	97,839.00	0	0	101975.84	4,799.68	106775.52
		1264	39589.24	7379.43	2000.00	0.00	379750.58	0.00	0.00	428719.25	71866.77	500586.02

Grand Total=1456531.31

Comments.

Budget Justification

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Direct Labor Hours. Provide estimated hours proposed for each individual.

YEAR 1 Environ. Scientist II 484 Accountant 100 Contract Manager 80 Environ. Analyst 480 System Analyst 40 GIS Analyst 40 Graphics Designer 40 YEAR 2 Environ. Scientist II 484 Accountant 100 Contract Manager 80 Environ. Analyst 480 System Analyst 40 GIS Analyst 40 Graphics Designer 40 YEAR 3 Environ. Scientist II 484 Accountant 100 Contract Manager 80 Environ. Analyst 480 System Analyst 40 GIS Analyst 40 Graphics Designer 40

Salary. Provide estimated rate of compensation proposed for each individual.

HOURLY SALARY RATES YEAR 1 Environ. Scientist II 39.60 Accountant 23.10 Contract Manager 24.26 Environ. Analyst 20.35 System Analyst 21.53 GIS Analyst 25.20 Graphics Designer 21.32 YEAR 2 Environ. Scientist II 41.58 Accountant 24.26 Contract Manager 25.47 Environ. Analyst 21.37 System Analyst 22.60 GIS Analyst 26.46 Graphics Designer 22.38 YEAR 3 Environ. Scientist II 43.66 Accountant 25.47 Contract Manager 26.74 Environ. Analyst 22.44 System Analyst 23.73 GIS Analyst 27.78 Graphics Designer 23.50

Benefits. Provide the overall benefit rate applicable to each category of employee proposed in the project.

18% of salary

Travel. Provide purpose and estimate costs for all non-local travel.

All travel will be local.

Supplies & Expendables. Indicate separately the amounts proposed for office, laboratory, computing, and field supplies.

None

Services or Consultants. Identify the specific tasks for which these services would be used. Estimate amount of time required and the hourly or daily rate.

Task 2A: Fish Sampling (DRSFMP Sites) Dave Kohlhorst and Staff Year 1: Labor (4160 hours); TOTAL $54,000 Year 2: Labor (4160 hours); TOTAL $54,000 Year 3: Labor (4160 hours); TOTAL $54,000 Labor includes 2 Scientific Aides at 100% each. Task 2B: Fish Sampling (non-DRSFMP Sites) SJSUF and DFG Staff Year 1: Labor (390 hours); Salary - $5,878; Benefits $1,487; Travel - $3,000; Supplies - $3,900; Services - $19,636; Other Direct $6,500; Indirect - $3,709; TOTAL - $44,110 Year 2: Labor (390 hours); Salary - $6,171; Benefits $1,561; Travel - $3,000; Supplies - $3,900; Services - $20,168; Indirect - $3,805; TOTAL - $39,056 Year 3: Labor (390 hours); Salary - $6,480; Benefits $1,639; Travel - $3,000; Supplies - $3,900; Services - $21,649; Indirect - $3,905; TOTAL - $40,574 Labor includes Project Assistant 2 at 20%, Project Assistant 1 at 2% Travel funds for project assistants travel expenses for collection of samples Supplies including fishing gear, bait, nets, gloves, teflon sheets and miscellaneous items pertaining to fishing. Services contracted to Dept. of Fish and Game ESIII Gary Ichikawa for fish sampling. This contract contains funds for 25% of his salary of $50,689 per year, plus $3,000 in travel. Overhead for DFG equals 15.3%, benefit rate equals

28% Other direct charge = overhead (26%) of first $25,000 of Service contract. Task 2C: Sample Processing SJSUF Staff Year 1: Labor (1660 hours); Salary - $23,074; Benefits - $5,838; Supplies - $3,000; Indirect - $8,297; TOTAL - $40,209 Year 2: Labor (1660 hours); Salary - $24,228; Benefits - $6,130; Supplies - $3,000; Indirect - $8,673; TOTAL - $42,030 Year 3: Labor (1660 hours); Salary - $25,439; Benefits - $6,436; Supplies - $3,000; Indirect - $9,068; TOTAL - $43,943 Labor includes Project Assistant at 90% Supplies include laboratory items such as jars ,acid, teflon sheets, scalpels, gloves, instrument maintenance, equipment maintenance Task 3A: Sport Fish Chemical Analysis SJSUF Staff Year 1: Labor (1,935 hours); Salary - $28,963; Benefits - $7,328; Supplies - $4,300; Services - $15,500; Equipment - $5,000; Indirect - $15,884; TOTAL - $76,974 Year 2: Labor (1,935 hours); Salary - $30,411; Benefits - $7,694; Supplies - $9,300; Services - $15,500; Indirect - $16,355; TOTAL - $79,261 Year 3: Labor (1,935 hours); Salary - $31,932; Benefits - $8,079; Supplies - $9,300; Services - $15,500; Indirect - $16,851; TOTAL - $81,661 Labor includes Project Assistant at 106% Supplies include laboratory items such as jars ,acid, teflon sheets, scalpels, gloves, balance, ICPMS supplies, Polytron tissue grinder Services include funds for analysis of 5% of samples (25 samples/yr) by an independent lab and analysis of stable isotopes by a subcontractor ($13,000/yr for 420 samples/yr) Equipment includes $5,000 for a scale for small masses Task 4A: Small Fish Sampling and Chemical Analysis Darell Slotton UC Davis Year 1: Labor (1,310 hours) - $35,470; Travel - $792; Supplies - $1,584; TOTAL - $37,846 Year 2: Labor (1,310 hours) - $37,241; Travel - $832; Supplies - $1,663; TOTAL - $39,736 Year 3: Labor (1,310 hours) - $39,114; Travel - $873; Supplies - $1,747; TOTAL - $41,734 Labor includes project leader, project manager, and head analyst at 18%; student helper at 9% Travel funds for field mileage reimbursement (personal vehicles); attendance of Technical Advisory Committee and other mtgs, Supplies for miscellaneous field, laboratory, and office needs Task 6A: Stakeholder and Public Outreach Maura Mack California Department of Health Services/Environmental Health Investigation Branch Year 1: Labor (1,664 hours) - $49,683; Travel - $4,090; Supplies - $15,960; Services - $7,500; Indirect Costs - $12,738 TOTAL - $89,971 Year 2: Labor (1,664 hours) - $52,664; Travel - $4,090; Supplies - $16,171; Services - $7,500; Indirect Costs - $13,370 TOTAL - $93,795 Year 3: Labor (1,664 hours) - $55,824; Travel - $4,090; Supplies - $16,387; Services - $7,500; Indirect Costs - $14,038 TOTAL - $97,839 Labor costs = 0.80 FTE each year. Positions are 1) Outreach and Education Coordinator (0.5 FTE); 2) Administrative Assistant (0.25 FTE); 3) Graphic Designer (0.05 FTE). Benefits are included at 33.7% of salaries. All salaries and benefits are subject to annual merit and COLA increases of up to 6%. Travel costs = Coordinator will travel by car to the Delta counties involved in the study. Lodging, car rental, per diem, and mileage expense are included. Supplies = This category includes postage for mailings, educational materials, and Other Direct costs charged by the State for contract staff who use State facilities. These costs may be subject to an increase of 2% each year for inflation. Services = This category includes translation and interpretation support, and advisory group expenses. Indirect Costs = Impact Assessments Indirect Costs cover the general administrative activities required to execute the awarded contract including financial management, project monitoring and reporting, personnel administration, secondary subcontract administration, consultant purchasing and lease agreement negotiation. The Indirect Cost rate is 19.8% of Direct Costs less any costs associated with subcontracts and equipment.

Equipment. Identify non-expendable personal property having a useful life of more than one (1) year and an acquisition cost of more than $5,000 per unit. If fabrication of equipment is proposed, list parts and materials required for each, and show costs separately from the other items.

None

Project Management. Describe the specific costs associated with insuring accomplishment of a specific project, such as inspection of work in progress, validation of costs, report preparation, giving presentatons, reponse to project specific questions and necessary costs directly associated with specific project oversight.

YEAR 1 1A Subcontracting $11,827.94 1B Review and Prepare Invoices and Quarterly Reports $10,441.15 1C Project Coordination (Planning, Sampling Design, Meetings, Communication) $27,349.02 1D Peer Review coordination $27,132.06 1E QA Oversight $4,345.28 1F Data Mgmt/GIS/Web $10,497.58 1G Annual Report Production $3,510.80 YEAR 2 1A Subcontracting $12,419.88 1B Review and Prepare Invoices and Quarterly Reports $10,963.45 1C Project Coordination (Planning, Sampling Design, Meetings, Communication) $28,667.37 1D Peer Review coordination $27,488.67 1E QA Oversight $4,562.84 1F Data Mgmt/GIS/Web $11,022.28 1G Annual Report Production $3,685.62 YEAR 3 1A Subcontracting $13,040.03 1B Review and Prepare Invoices and Quarterly Reports $11,510.96 1C Project Coordination (Planning, Sampling Design, Meetings, Communication) $30,051.76 1D Peer Review coordination $27,863.28 1E QA Oversight $4,791.21 1F Data Mgmt/GIS/Web $11,573.40 1G Annual Report Production $3,870.05

Other Direct Costs. Provide any other direct costs not already covered.

None

Indirect Costs. Explain what is encompassed in the overhead rate (indirect costs). Overhead should include costs associated with general office requirements such as rent, phones, furniture, general office staff, etc., generally distributed by a predetermined percentage (or surcharge) of specific costs.

Indirect costs include rent, telephone, office supplies, office equipment, administrative staff, administrative time, and holiday, vacation, and sick time. Indirect costs are calculated as 153% of salary + benefits.

Executive Summary

MERCURY IN DELTA FISH: ESTABLISHING A NETWORK FOR LONG TERM STUDY

CALFED restoration and water management actions will lead to local and possibly regional increases in concentrations of mercury in aquatic food webs and exacerbate the existing mercury problem. Recent studies in the Delta have found striking regional variation in mercury bioaccumulation. To date, little effort has been made to identify local communities who may be impacted by elevated mercury in Delta fish. Outreach to these communities is the most rapid and effective means of reducing the impacts of mercury on human health. The mercury problem is going to persist in the watershed for decades, perhaps centuries. Long term, multi-disciplinary, process-oriented studies are needed in order to develop a capability to predict the impact of CALFED actions on mercury bioaccumulation and to evaluate the impact of CALFED actions, both on a project and regional level, in support of an adaptive management approach. Sport fish and prey fish sampling should be included in these studies, as they are excellent indicators of human exposure, wildlife exposure, and spatial and temporal trends. The goal of this proposed 3-year monitoring project is to establish a network of long term monitoring sites for tracking the effectiveness of CALFED efforts to minimize mercury bioaccumulation in the Delta region. The objectives of the project are: 1. Establish a sound statistical foundation for evaluating long term trends in mercury bioaccumulation. 2. Provide data on mercury bioaccumulation at selected Delta sites that can be linked to other studies to gain a comprehensive understanding of mercury movement from water and sediment into the food web. 3. Develop an improved understanding of the processes driving interannual variation in mercury bioaccumulation. 4. Provide sport fish mercury data that can be used in evaluating human health risks. 5. Evaluate spatial patterns in mercury bioaccumulation in the Delta. 6. Provide the opportunity for local community involvement in the dissemination of study results. 7. Provide public education and outreach on mercury in Delta fish. 8. Enhance local health department capacity to address public concerns about mercury in sport fish. The hypotheses to be evaluated are as follows: 1. Management actions will lead to localized and regional changes in long term trends in fish mercury. 2. Fish mercury will continue to show regional spatial variation. Annual sampling of largemouth bass, other sport fish, and lower trophic level organisms (small fish and clams) will be performed. A group of stakeholders will be formed and will provide a channel for public outreach and education. Expected outcomes of the project include peer reviewed reports on results; accessible data, maps, and reports; presentations at review meetings, symposia, and stakeholder meetings; an organized network of local stakeholders; educational materials for targeted fish-consuming populations; and training workshops and educational materials for local health departments. This project will address many CALFED priorities relating to water quality, local involvement, and environmental justice. Water quality issues relate to remediating the existing beneficial use impairment and ensuring CALFED does not exacerbate the problem through habitat restoration and water management. Mercury in sport fish is a critical performance measure with regard to the mercury problem.

Proposal

San Francisco Estuary Institute

MERCURY IN DELTA FISH: ESTABLISHING A NETWORK FOR LONG TERM STUDY

Jay Davis, San Francisco Estuary Institute
Mark Stephenson, San Jose State University Foundation
Maura Mack, California Department of Health Services
Darell Slotton, UC Davis

MERCURY IN DELTA FISH: ESTABLISHING A NETWORK FOR LONG TERM STUDY

A. Project Description: Project Goals and Scope of Work

1. Problem

Present concentrations of mercury in aquatic food webs in the Delta region are high enough to warrant concern for the health of humans and wildlife. Concern for human health stems from mercury exposure through consumption of contaminated sport fish. CALFED restoration and water management activities will lead to local and possibly regional increases in concentrations of mercury in aquatic food webs and exacerbate the existing mercury problem.

The mercury problem in northern California was created in the 1800s and has been recognized in the Delta since 1969 (California State Department of Public Health 1971). In spite of this long history, mercury has a complex biogeochemical cycle that is only beginning to be understood in this system. The CALFED Mercury Project (Stephenson et al. 2001, Davis et al. 2001), an ERP directed action that funded a two year multidisciplinary detailed study of mercury in the Delta, and other recent studies in the region (Davis et al. 2000a, Larry Walker Associates 2000, 2001) have found striking regional variation in mercury bioaccumulation that currently defies explanation. Mercury cycling in the Delta and its watershed is presently not understood well enough to allow confident predictions of the local or regional impact of CALFED actions.

The mercury problem is going to persist in the watershed for decades, and perhaps centuries. Long term, process-oriented studies are needed in order to develop a capability to predict the impact of CALFED actions on mercury bioaccumulation. Long term studies are also needed to evaluate the impact of CALFED actions, both on a project and regional level, in support of an adaptive management approach. These studies should be multidisciplinary, since many steps in the mercury cycle, from water chemistry to microbial dynamics to food web structure, can make the difference between concentrations in fish being safe or potentially harmful. The studies should be conducted at a network of sites that are representative of a range of conditions, since mercury accumulation is spatially variable, and different sources, environmental conditions, and management actions will prevail in different regions.

Sport fish sampling should be included in the long term studies, as sport fish are a fundamental indicator of beneficial use impairment. Sampling of lower trophic level organisms is also essential, as they are the best indicators of exposure of piscivorous wildlife and of mercury entry into the food web, and they provide a signal of spatial and temporal variability in mercury availability that is less influenced by food web structure. Study of other important processes (e.g., water and sediment concentrations, methylation and demethylation activity, flux rates from sediment to water) at the long term study sites, as proposed in other PSP submissions (see Section B.2. below), would provide a basis for developing models and a predictive capability regarding mercury fate in the ecosystem.

Fishing for food and recreation occurs extensively throughout the Delta area. Anglers in the Delta include ethnic populations who rely on their catch as a source of food for their families. Local communities, including anglers and their families, must have the opportunity to participate in the planning and development of activities to characterize and remediate this problem that may impact their health. To date, little effort has been made to identify local communities who may be impacted by elevated mercury levels in Delta fish. Currently, the most effective way to reduce human exposure to mercury from consumption of contaminated fish is to educate fish consumers about the possible hazards and convince them to limit the amount of fish they consume. Involvement by the local community is essential to disseminating the results of sampling efforts and educating them about the health risks.

Project Goal

Establish a network of long term monitoring sites for tracking the effectiveness of CALFED efforts to minimize mercury bioaccumulation in the Delta region.

Objectives

1. *Establish a sound statistical foundation for evaluating long term trends in mercury bioaccumulation.*
2. *Provide data on mercury bioaccumulation at selected Delta sites that can be linked to other studies to gain a comprehensive understanding of mercury movement from water and sediment into the food web.*
3. *Develop an improved understanding of the processes driving interannual variation in mercury bioaccumulation.*
4. *Provide sport fish mercury data that can be used in evaluating human health risks.*
5. *Evaluate spatial patterns in mercury bioaccumulation in the Delta.*
6. *Provide the opportunity for local community involvement in the dissemination of study results.*
7. *Provide public education and outreach on mercury in Delta fish.*
8. *Enhance local health department capacity to address public concerns about mercury in sport fish.*

2. Justification

Conceptual Models Relating to Mercury Accumulation in the Watershed

Biogeochemical Cycling of Mercury

Mercury exists in the environment in a variety of forms and has a complex biogeochemical cycle that makes it difficult to predict spatial and temporal patterns in food web contamination. A few aspects of the cycle relevant to this proposal are described here. This summary is excerpted from a review by Davis et al. (2000b); the extensive list of references cited in the review is omitted here due to space limitations. The most important forms of mercury in the Bay-Delta watershed are elemental or metallic

mercury (Hg^0), mercuric mercury (Hg^{+2}), cinnabar or mineral mercury (HgS, which is one form of mercuric mercury), and monomethyl mercury (CH_3Hg^+, commonly referred to as "methylmercury").

Methylmercury is the form of mercury in the aquatic environment that is readily accumulated by aquatic biota, transferred through the food web, and transferred into the sensitive nervous systems of piscivorous wildlife and humans. Methylmercury is produced through addition of a methyl group to Hg^{+2}, a process referred to as methylation. Methylation is performed primarily by sulfate-reducing bacteria, which are found at zones of transition from oxic to anoxic conditions in the water column or sediment. Methylmercury can also be converted back into Hg^{+2}, primarily via bacterial degradation, in a process known as demethylation. Dissolved methylmercury is short-lived; it is rapidly either taken up into the food web or demethylated.

HgS (solid phase cinnabar) is the predominant form present in runoff from the mercury mining regions of the Coast Range on the west side of the Central Valley. HgS must be transformed to dissolved Hg^{+2} or a dissolved Hg-sulfide complex before it can be converted to methylmercury. This is a slow process because HgS is extremely insoluble, although the process of mining and roasting mercury ore increases its solubility. Hg^0 (elemental mercury) is the predominant form contaminating the gold mining regions of the Sierra Nevada on the east side of the Valley. Hg^0 must be oxidized to Hg^{+2} before it can be converted to methylmercury. Hg^0 also has low solubility in water, and this limits its rate of conversion to Hg^{+2}. Hg^0 appears to be relatively non-reactive in water. High concentrations of mercury in aquatic food webs in Delta tributaries from both sides of the Valley indicate that both HgS and Hg^0 are reactive enough in this watershed to be converted to methylmercury.

The precise mechanism for entry of methylmercury to the food chain is unknown, but either involves the consumption of methylmercury-containing bacteria by plankton or direct adsorption of methylmercury dissolved in water. This initial step is critical, because concentrations of mercury in plankton are about 10,000-fold higher than in water. After this initial step, methylmercury concentrations increase approximately three-fold with each additional step in the food chain, in a process known as biomagnification. In this process consumers retain and further concentrate much of the methylmercury of the prey they consume throughout their lives and subsequently pass this on to the next trophic level. Species at high trophic positions in the aquatic food web, such as predatory fish, attain concentrations that are approximately a million times higher than concentrations in water.

High trophic level sport fish species, such as largemouth bass, white catfish, and striped bass, are important in characterizing mercury contamination because they are indicators of human exposure. In the Central Valley, largemouth bass have proven to be a particularly valuable indicator because they are abundant, broadly distributed, and accumulate relatively high mercury concentrations. They have also been useful in characterizing spatial variation (Figure 1), consistent with tag return studies that have found them to have strong site fidelity (Ray Schaffter, CDFG, personal communication). White catfish are also abundant, broadly distributed, and accumulate relatively high concentrations of mercury. Striped bass are a popular sport fish species that periodically exhibit very high mercury concentrations, but are not as abundant as largemouth bass and white catfish and are highly migratory.

Low trophic level species are also important in characterizing mercury contamination because they are indicators of exposure of piscivorous wildlife and they provide a signal of spatial and temporal variability in mercury bioavailability that is minimally influenced by food web structure and migration. Inland silversides (see Figure 2) and *Corbicula* (Figure 3) have proven to be good indicator species for the Delta because of their wide distribution and the distinct regional spatial variation they have exhibited (Slotton et al. 2001).

Mercury concentrations in sport fish and lower trophic level organisms will be a critical performance measure for CALFED's progress in addressing the mercury problem. Several factors will cause temporal variation in mercury in fish in the watershed, including net methylmercury production and fish characteristics such as age, trophic position, growth rate, and consumption rate. CALFED restoration actions could cause changes in these factors, with resulting changes in bioaccumulation.

A decrease in net methylmercury production is the change that would meet the goals of CALFED. Many factors influence net methylmercury production, including total mercury concentrations, activity of methylating and demethylating bacteria, and mercury speciation. Mercury speciation and microbial activity in turn are influenced by several environmental factors, including redox potential, pH, salinity, dissolved organic carbon, concentrations of sulfur compounds, and temperature. The complex assortment of factors that can affect net methylmercury production make it difficult to reliably predict when or where mercury will accumulate excessively in food webs. For example, sampling performed in CALFED-funded studies in the Delta (Davis et al. 2001, Slotton et al. 2001) has found a region of inexplicably low food web mercury concentrations in the Central Delta, in spite of the high concentrations surrounding this region (Figures 1, 2, and 3).

CALFED is undertaking many actions that can actually be *expected* to *increase* net methylmercury production. CALFED aims to create wetlands, floodplains, and reservoirs to increase habitat for priority fish species and increase water storage. Wetlands and reservoirs, particularly recently flooded reservoirs, are two types of habitats that have frequently been associated with particularly high rates of methylmercury production. Several studies have found correlations between the percentage of wetlands in a watershed and concentrations of methylmercury in waters leaving the watershed. Regarding reservoirs, it is well established that mercury present in soils and vegetation is released into the aquatic environment after flooding and transformed into methylmercury, with resulting increases in fish tissue concentrations. Methylmercury production is particularly intense in flooded wetlands, due to the large quantities of organic carbon present. In subarctic reservoirs fish mercury concentrations remain elevated for 20-30 yr after flooding. However, some examinations of Hg concentrations in fish tissues from impounded lakes and restored wetlands (Suchanek et al. 1999, Slotton et al. 2001) have not shown significant patterns with respect to the age of the lake or wetland. Floodplains share the properties (i.e., anoxic conditions at the sediment/water interface and an abundant supply of carbon) that favor methylation in wetlands and reservoirs. As CALFED proceeds, it will be important to perform systematic monitoring to evaluate the possibility of a general regional increase in mercury due to increases in the acreages of wetlands, floodplains, and reservoirs in the watershed.

CALFED actions could also *possibly* increase mercury in sport fish through effects on trophic position. Fish at higher trophic positions accumulate higher mercury concentrations. Habitat enhancement aimed at increasing populations of fish and their prey could lead to an increase in the length of food chains and the average trophic position of predatory sport fish species. Unintentional species introductions are another common occurrence in the Estuary that can lead to longer food chains.

These actions that could increase mercury in the food web will be hopefully outweighed by actions by CALFED and the Regional Water Quality Control Board to improve water quality with respect to mercury, either by reducing total mercury concentrations or methylmercury production. Overall, considering the potential impacts of all of these management actions, it is *probable* that we will begin to see localized long term changes in fish mercury concentrations near the sites of restoration, remediation, or hydrologic modification. It is also *possible* that the combined effect of all of this management activity will lead to regional changes in fish mercury. It is imperative to establish a network of long term monitoring stations to evaluate these changes.

In the absence of effective remediation efforts, the forecast for mercury in the watershed appears to be for a very slow decline. A watershed-scale mass budget for mercury would be needed to forecast the recovery of the watershed from mercury contamination. Such a mass budget has not yet been developed. However, the response time of the watershed for mercury is probably centuries. The massive scale of contamination from mercury and gold mining has tainted nearly the entire watershed. Hydraulic mining, in particular, mobilized and contaminated vast amounts of sediment that have been shown to persist in floodplains, wetland sediments, and on the floor of San Francisco Bay (Davis et al. 2000b). Periodic remobilization of contaminated sediment deposits by large storms or other processes will continue to supply mercury to the water column. In spite of the volatility of elemental mercury, drops or pools of mercury can still be found in the bottom of streams and rivers in the Sierra and in the Coast Range, over 100 years after it was released. The best long term dataset on bioaccumulation is for striped bass in the Delta region, and shows no evidence of a decline in the last 30 years (Davis et al. 2001). While the complex interplay of processes involved in the mercury cycle can be expected to lead to some interannual variation in mercury concentrations, it can also be expected that, in the absence of management actions, the overall rate of decline will be imperceptible on the scale of a few years.

The key to detecting real change in sport fish mercury will be filtering out the interannual variation to reveal actual long term trends. This will require understanding the causes and magnitude of interannual variation.

Summary of Conceptual Models

- Mercury has a complex biogeochemical cycle that makes it difficult to predict spatial and temporal patterns in food web contamination.
- Through biomagnification, predatory fish attain mercury concentrations that are approximately a million times higher than concentrations in water.

- High trophic level sport fish species are essential indicators of mercury contamination, useful in characterizing human exposure, contaminated food webs, and spatial and temporal variability in the watershed.
- Largemouth bass are a particularly valuable indicator species because they are high in the food web (therefore accumulating high mercury concentrations), abundant, broadly distributed, popular with anglers, and generally nonmigratory.
- Low trophic level species (i.e., small fish and clams) are valuable indicators of exposure of piscivorous wildlife and spatial and temporal variability in mercury entering the food web.
- Management actions of CALFED and the Regional Water Quality Control Board will lead to fluctuations in long term trends on a local scale, and could lead to long term increases or decreases on a regional scale.
- The complex interplay of processes involved in the mercury cycle can be expected to lead to interannual variation in mercury concentrations. The key to detecting real change in fish mercury will be understanding and filtering out the interannual variation to reveal actual long term trends.

Hypotheses and Means of Evaluation

1. *Management actions will lead to local and regional changes in long term trends in fish mercury*. Establish a network of long term sampling sites to begin characterizing interannual variability and provide a solid basis for evaluation of long term trends.
2. *Fish mercury will continue to show regional spatial variation.* Distribute sampling sites across known regional gradients of contamination.

Project Type

This would be a monitoring project. The Draft Implementation Plan states that the science-based adaptive management approach "will rely on constant monitoring and evaluation of actions in all Program elements." This project would allow evaluation of the regional effects of Program actions on the mercury problem by providing a firm foundation for problem reassessment as Program actions proceed. The project would also provide initial problem definition through characterization of interannual variability in fish mercury, which will be essential in interpreting long term trends. The project would provide information on the processes that influence mercury accumulation in fish, and through linkage with other proposed process-oriented studies at the sampling sites would lead to improved conceptual models for mercury fate. It will be important to establish this long term monitoring network as soon as possible prior to large scale restoration activities in the watershed. Once established, annual monitoring at these sites should be maintained for several years until interannual variability is characterized adequately to allow a rigorous analysis of the statistical power to detect trends over time. After this initial period, less frequent monitoring could be performed to track long term progress in reducing mercury concentrations.

3. Approach

Study Design

Ten sites will be sampled each year in this three year project. The sites will be selected in collaboration with other investigators proposing to perform long term, process-oriented mercury sampling in the Delta (see Section B.2.). Sampling will occur once each year in late summer.

This project would be carried out in collaboration with the Delta Resident Shoreline Fish Monitoring Project (DRSFMP) of the Interagency Ecological Program, conducted by the California Department of Fish and Game. The DRSFMP is a long term study of trends in populations and trophic interactions of popular sport fish species in the Delta. In the DRSFMP, year-round monthly sampling is being performed at randomly selected sites within five blocks in the Delta (Figure 4). Fish abundance (measured by electroshocking) and gut contents of dominant species are being measured monthly. In late summer of the three years of this proposed project, the DRSFMP will sample one fixed site within each of the five DRSFMP blocks. Collaboration with the DRSFMP will provide an opportunity to collect fish in a cost-effective manner (they will collect fish while they are performing their abundance survey) and to obtain detailed food habit information that will be of tremendous value in understanding mercury accumulation in largemouth bass and white catfish.

Sampling performed to date has found concentrations in largemouth bass that range from 1 ppm and above at locations on the periphery of the Delta to 0.1 ppm in the Central Delta. Central Delta sites will be covered by the DRSFMP blocks. The remaining five sites will be selected to build on existing data, to indicate trends in different tributaries and provide a representative assessment of spatial patterns in the Delta (to meet Objective 5), and to represent locations with elevated food web mercury. Candidates for these sites include the Sacramento River at River Mile 44, the Cosumnes River, the San Joaquin River at Vernalis, the Feather River at Nicolaus, and Prospect Slough (Figure 2). Final site selection and other decisions on the details of sampling design will be made in consultation with the peer review panel and other researchers performing long term mercury studies in the Delta (Objective 2).

Sampling and Analytical Chemistry

Sport fish species to be sampled will include largemouth bass, white catfish, striped bass, and other less abundant sport fish such as bluegill and redear sunfish. For largemouth bass and white catfish we will attempt to catch 15 fish at each site. Legal size striped bass are less abundant, and we will attempt to collect an average of 4 at each site. To provide data that can be used in subsequent human health risk evaluations (Objective 4), five of the 15 fish collected at each site will be within a defined size range, consistent with previous human health oriented studies in the watershed (Davis et al. 2000a, Davis et al. 2001, Larry Walker Associates 2000, 2001). To provide the best foundation for future evaluation of long term trends and interannual variation at sites sampled in this project (Objectives 1 and 3), we will also collect additional fish above and below the target range in order to establish the size:Hg relationship. Muscle tissue from each fish will be analyzed individually for mercury and stable isotopes

of nitrogen and carbon. Analysis of the stable isotopes is relatively inexpensive and provides valuable information on trophic position and food source.

Lower trophic level species will also be sampled as trend indicators and to aid in interpretation of the sport fish mercury data. *Corbicula*, the dominant clam in the region, and inland silversides, an abundant planktivorous fish species, will be collected and analyzed for mercury and stable isotopes of nitrogen and carbon. Methylmercury will be measured in the clams and total mercury in silversides (previous work by Slotton et al. 2001 has shown that most of the mercury in silversides is methylmercury). Triplicate composites consisting of 10 individual *Corbicula* and silversides of a predetermined size will be analyzed from each site. Single composites of four other small fish species will also be analyzed. Isotope data from these species will be used to baseline correct the sport fish data from each site.

Gut contents of all collected largemouth bass, white catfish, and striped bass will be analyzed. Gut content analyses will be performed by Bay-Delta DFG staff. In addition, integration of this study with the DRSFMP will facilitate comparison with the monthly gut content data that will be obtained for the five blocks in the Delta. Ages of largemouth bass and striped bass will be determined through otolith analysis. Ages of white catfish will be determined by analyzing scales.

Fish samples at non-DRSFMP sites will be collected by Moss Landing Marine Laboratory (MLML) by electroshocking (with an e-boat), fyke nets, gill nets, or other methods. Total length and fork length will be measured in the field. Samples will be stored and processed using non-contaminating techniques, following protocols established for the CALFED Mercury Project, RMP, and SRWP. Fish samples at DRSFMP sites will be collected by retaining fish captured during electroshocking. These samples will also be stored and processed using clean techniques. Small fish will be collected by beach seine, and clams will be collected by hand.

Total mercury concentrations in sport fish muscle will be analyzed by MLML. Tissue samples will be digested with a 70:30 nitric:sulfuric acid solution. Samples will be analyzed using a Perkin Elmer Flow Injection Mercury System (FIMS) with an AS-90 autosampler. Methylmercury in clams will be analyzed by MLML using a digestion in 25% KOH/methanol followed by an isothermal GC separation of ethyl analogs and cold vapor atomic fluorescence (CVAFS). Samples, blanks, reductant, and standards will be prepared using clean techniques. ASTM Type II water and ultra clean chemicals were used for all standard preparations. A continuing calibration verification will be performed after every 10 samples and samples run between CCVs that drift greater than 10% will be rerun. Three blanks, a standard reference material (DORM-2 for total and methylmercury), as well as a method duplicate and a matrix spike pair will be run with each set of samples.

UC Davis will collect, process, and analyze mercury concentrations in lower trophic level biota. These samples will be sorted, identified, and cleaned within 24 hours, and subsequently dried and powdered, all using standard trace metal clean technique. Samples will be digested in a nitric:sulfuric acid mixture and stabilized with potassium permanganate. Sample preparatory, digestion, and Hg analytical work at UC Davis will follow protocols employed in the CALFED Mercury Project and

refined over many years. Mercury analytical utilizes standard cold vapor atomic absorption spectroscopy (modified EPA Method 245.2) with extensive QA/QC.

In general, project QA requirements will be the same as those established for the CALFED Mercury Project (Davis et al. 2001). If Frontier Geosciences receives next phase funding to continue as QA officer for CALFED mercury studies, we will participate in their program. Splits of 5% of samples will be analyzed by Frontier or another independent lab. Sufficient tissue mass from each sample will be archived to allow for reanalysis.

Data Analysis

Within each site, the size:mercury relationship for each species will be evaluated by regression to allow comparisons of standard sized fish among sites and within sites over time. Statistical techniques presently under development in the CALFED Mercury Project will be employed, including the polynomial regression technique of Tremblay et al. (1998). Polynomial regression is an alternative to conventional analysis of covariance that requires fewer assumptions and is therefore more appropriate for typical fish mercury data.

Stakeholder Coordination and Public Outreach

The approach for providing outreach to stakeholders and the public is described in Section E (Local Involvement) below.

4. Feasibility

SFEI and MLML have collaborated on sport fish sampling projects for the past 5 years, including the Sacramento River Watershed Program, the Delta Fish Study, the CALFED Mercury Project, and a CALFED-funded study evaluating contaminant effects on splittail. Based on experience from these projects, and in particular on experience from the CALFED Mercury Project, it is certainly feasible to conduct this sampling. The DFG staff that would perform the sampling have the permits needed to collect fish in the region. UC Davis has conducted sampling of small fish and clams in the region for many years, including extensive sampling in the ERP project "Effects of Wetland Restoration on Methylmercury Levels." The smaller scale effort for UCD proposed here is clearly feasible.

5. Performance Measures

The best way to ensure that this project successfully meets its goals and objectives will be to include high quality peer review in all phases, from design through implementation and interpretation. The model established in the CALFED Mercury Project will be followed. Mark Stephenson is submitting a proposal to CALFED for next phase funding for the Science Review Panel established for the CALFED Mercury Project. If this Panel does continue, they would provide peer review for this project.

The success of this project will be evaluated by the following performance measures:

- *Complete subcontracts with MLML, DFG, UC Davis, and DHS*
- *Submit quarterly fiscal and programmatic reports on time*
- *Develop peer-reviewed annual sampling plans*
- *Obtain target numbers of fish in defined size ranges from each sampling location*
- *Prepare sampling report*
- *Meet data quality objectives for chemical analysis*
- *Complete chemical analysis and QA/data report in May of each year*
- *Complete peer-reviewed annual project reports presenting findings and project progress*
- *Present findings at annual review meetings, other symposia, and at meetings of stakeholder groups*
- *Convene quarterly stakeholder group meetings*
- *Conduct local health department need assessments and trainings*
- *Effectively distribute results to local agencies, environmental groups, the media, and the public*
- *Produce peer-reviewed final report*
- *Present findings and raw data on the web*
- *Publish results in peer-reviewed journal*

6. Data Handling and Storage

SFEI will manage the data from this study using procedures developed for the Regional Monitoring Program for Trace Substances, whose data SFEI has been successfully managing for the past seven years. Analytical results will be transferred to SFEI in Microsoft Excel spreadsheets by the laboratory and compiled into an Oracle database, which will be maintained by SFEI. To minimize data formatting by SFEI staff, templates and guidelines explaining the structure of the database's tables will be provided to the laboratories. Data will be reviewed to ensure that they are consistent with the format of the database and other data records. The database will be created in Access to allow for easy manipulation and retrieval of data, and transferred to Oracle for storage upon final validation of the data. Results will be compiled in a cross-tabular format (e.g. site, date, variable, result) for their QA review and reporting, and will be made accessible on SFEI's website.

7. Expected Products/Outcomes

- Peer-reviewed interpretive annual project reports
- Presentations at annual review meetings, symposia (e.g., CALFED Science Conference, NorCal SETAC, SETAC), and at meetings of stakeholder groups (e.g., the group formed to guide this project, the Sacramento River Watershed Program)
- Data, maps, and reports accessible through the SFEI website
- Peer-reviewed final report
- Peer-reviewed journal publication
- An organized network of stakeholders

- Educational materials for targeted fish-consuming populations, including translated materials for non-English speaking populations
- Training workshops and educational materials for local health departments

8. Work Schedule

The work schedule for the project is shown in Table 1. This schedule assumes that funds would be available and work could begin in Q3 of 2002. If funds were not available until Q4, then it may not be possible to have the sampling design peer reviewed prior to beginning sampling, and the project would have to wait until the following year. This would still be acceptable to SFEI, MLML, and DHS.

The tasks included in this proposal are generally inseparable. The multiple years of sampling are inseparable given the basic objective of the project to establish a time series of measurements at key sites. Task 4 (Small Fish Sampling and Chemical Analysis) could conceivably be separated, reducing the total project cost by $119,315, but this would leave a significant gap in long term mercury assessment in the Delta. Another task that could be separated is Task 6 (Stakeholder Coordination and Public Outreach), reducing the total cost of the project by $281,605, but this would eliminate an element of the proposal that CALFED emphasized in the Implementation Plan and the PSP.

B. Applicability to CALFED ERP and Science Program Goals and Implementation Plan and CVPIA Priorities

1. ERP, Science Program and CVPIA Priorities

This proposed project addresses one issue under one of the four objectives of the CALFED long-term, comprehensive plan (the Plan): to provide good water quality for all beneficial uses. The fish consumption advisories that have resulted from mercury contamination in sport fish represent a beneficial use impairment. Mercury accumulation in aquatic food webs is one of the most pressing water quality problems in the watershed.

The proposed project also addresses several of the Strategic Goals of the Ecosystem Restoration Program (ERP).

- Goal 3 is to "maintain and/or enhance populations of selected species for sustainable commercial and recreational harvest, consistent with the other ERP Strategic Goals." Objective 2 under Goal 3 is to "maintain, to the extent consistent with ERP goals, fisheries for striped bass…. and nonnative warmwater gamefishes" . This project would characterize impairment of the recreational harvest of striped bass and warmwater gamefishes.
- The most applicable goal is Goal 6: "Improve and/or maintain water and sediment quality conditions that fully support healthy and diverse aquatic ecosystems in the Bay-Delta watershed and eliminate, to the extent possible, toxic impacts to aquatic organisms, wildlife, and people." With regard to this goal the Implementation Plan states: "Persistent toxicants such as methyl mercury, selenium and PCBs can accumulate and concentrate in the aquatic food web creating health problems for carnivorous fish and for other predator organisms such as raptors and humans." Long term

sampling is needed to track the effectiveness of management efforts to reduce mercury contamination. Through active local community involvement and education human mercury exposure can be successfully reduced or eliminated. The Implementation Plan recognizes that the effect of toxic substances draws high public awareness and that environmental justice issues exist regarding the risks of consuming harvested organisms contaminated with persistent chemicals. Environmental justice is one of the CALFED Program's broad commitments. A key environmental justice issue relating to mercury contamination in fish is that mercury is most harmful to those most vulnerable--the developing fetus and young children. Protecting these groups can be difficult because pregnant women and mothers of young children may consume contaminated fish or feed it to their children but not be anglers themselves. Thus, they have less direct access to information about the hazards of contaminated fish. In addition, some ethnic communities or other subpopulations rely more heavily on harvested fish for nutrition, and are therefore more highly exposed to mercury and other persistent contaminants (SFEI 2001). Cultural and language barriers pose additional challenges to reaching these groups with information about contaminated fish. The local involvement activities included in this project would begin to identify and educate these adversely impacted groups.

This project would meet several of the stated priorities of the CALFED Science Program:

- *Develop performance measures*. Mercury concentrations in sport fish are arguably the most critical measure of success in remediating the mercury problem. Mercury concentrations in small fish and clams are valuable indicators of spatial and temporal mercury trends.
- *Advance process understanding.* The information obtained in this project would advance understanding of the processes which drive mercury accumulation in fish and how they vary over time and space. Linkage of this study with long term, process-oriented studies of other components of the mercury cycle at a network of sites in the Delta will lead to a comprehensive understanding of mercury fate in the ecosystem.
- *Establish integrated science programs in complicated field settings.* Linkage of this study with the other studies proposed for the Delta with coordinated QA, interpretation, and peer review will create an integrated program of mercury study. The Delta has certainly proven to be a complicated field setting for mercury.
- *Advance the scientific basis of regulatory activities.* This project would provide a firm basis for evaluating whether management activities are successful in addressing the mercury problem in the Delta region.
- *Coordinate and extend existing monitoring.* The proposed project would be coordinated with other existing monitoring activities (e.g., the Sacramento River Watershed Program), and would be coordinated with other studies of mercury fate and long term trends in the Delta region.
- *Address environmental justice issues.* This project will address environmental justice issues by involving populations who may be adversely impacted by mercury contamination in fish.

The objectives of the CALFED Plan, the Strategic Goals and objectives of the ERP, and the priorities of the Science Program are reflected in the multi-regional and regional priorities listed in the Implementation Plan and PSP. This proposed project would address the following priorities, as excerpted from the PSP.

- **Multi-Regional Priority 5: Ensure that restoration is not threatened by degraded water quality.** "Stage 1 actions include assessment of mercury sources, loadings, factors affecting transformation and bioaccumulation across the watershed."
- **Sacramento Region Priority 7: Develop conceptual models to support restoration of river, stream and riparian habitat.** Under "Implications of mine wastes for remediation": "Mitigation of (the effects of mine wastes) can be possible, but prioritization (what to mitigate, where), relative to other needs, requires understanding and comparing the concentrations, distribution, fate and effects of contaminated sediments in and among the tributary rivers and streams of the Sacramento."
- **Delta and Eastside Tributaries Region Priority 6: Restore shallow water habitats in the Delta for the benefit of at-risk species while minimizing potential adverse effects of contaminants.** "Better understand processes that determine mercury methylation in the Delta and tributaries, particularly how it is affected by restoration in different settings."

Although not listed as a priority in the Implementation Plan or PSP, significant mercury contamination of sport fish has also recently been identified in the San Joaquin River and its tributaries, with some largemouth bass exceeding 1 ppm (Davis et al. 2000, Davis et al. 2001). The needs with regard to mercury in the San Joaquin Region should be considered similar to those for the Sacramento and Delta and Eastside Tributaries regions, if not greater since less monitoring has been performed there.

The CALFED agencies are implementing the CALFED Program using a science-based adaptive management approach. This approach "will rely on constant monitoring and evaluation of actions in all Program elements." This proposed project would provide an essential foundation for evaluating progress toward the goal of remediating the mercury problem in the Delta region.

2. Relationship to Other Ecosystem Restoration Projects

This project would represent a continuation of two prior ERP projects: 1) the CALFED Mercury Project (sport fish sampling element), and 2) Effects of Wetlands Restoration on Methyl Hg Levels by UC Davis, as discussed in Section B.3. (Requests for Next-Phase Funding).

This project would also be coordinated with several other mercury projects proposed in this PSP.

1) *Transport, Cycling, and Fate of Mercury and Monomethyl Mercury in the San Francisco Delta and Tributaries, PI: Mark Stephenson, CDFG* Water and sediment mercury and methylmercury sampling would be performed at the same sites sampled in this project.
2) *An Assessment of Factors Affecting Bioaccumulation and Adverse Effects of Mercury to Birds of the Bay/Delta Watershed to Assist and Guide Future Mercury Control Strategies, PI: Steve Schwarzbach, USFWS* Avian sampling would be conducted at some of the same sites sampled in this project.
3) *Mercury in Central Valley Sport Fish: Defining the Mercury Problem, PI: Jay Davis, SFEI* These two proposals would be coordinated to avoid overlap. Data from the two studies

would be combined in interpretive reports and would be available from the same source (SFEI). Public outreach efforts in the two studies would also be coordinated.

4) *Development and Implementation of Bioaccumulation-Based Mercury Monitoring in Support of Restoration, Remediation, and the Regulatory Process, PI: Darell Slotton, UC Davis* Sampling would be coordinated with this project to maximize the information obtained.

3. Request for Next Phase Funding

This project would be a continuation of the fish sampling elements of two previous ERP projects: *ERP-99-B06 Assessment of the Ecological and Human Health Impacts of Mercury in the Bay-Delta Watershed* and *ERP-97-C05 Effects of Wetlands Restoration on Methyl Hg Levels.* This project would continue sampling at a subset of the sites sampled in the previous projects to begin building a long term time series, and would employ approaches that were developed and refined during the previous studies. The progress and accomplishments of the previous projects are described in Attachments 1 and 2.

3. Previous recipients of CALFED Program or CVPIA Funding

SFEI and MLML: *ERP-99-N07 Chronic Toxicity of Environmental Contaminants in Sacramento Splittail: A Biomarker Approach* – The project is in its second year. SFEI and MLML are performing field sampling and analytical chemistry. The first year of field sampling has just been completed. *ERP-99-B06 Assessment of the Ecological and Human Health Impacts of Mercury in the Bay-Delta Watershed* – SFEI and MLML are performing fish sampling and mercury analysis. The project is in its third year. Two years of sampling and chemical analysis have been completed and a final report is in preparation (see Attachment 1).

SFEI: *CALFED Whitepaper on: Ecological Processes in Tidal Wetlands of the Sacramento-San Joaquin Estuary and Their Implications for Proposed Restoration Efforts of the Ecosystem Restoration Program.* Dr. Davis was lead author of chapter: "Mercury and Tidal Wetland Restoration." The draft report has been completed.

MLML: *ERP-99-B06 Assessment of the Ecological and Human Health Impacts of Mercury in the Bay-Delta Watershed* – The project is in its third year. Two years of sampling and chemical analysis have been completed and a final report is in preparation.

UC Davis: *ERP-97-C05 Effects of Wetlands Restoration on Methyl Hg Levels* – Progress on this project is summarized in Attachment 2. *ERP-99-B06 Assessment of the Ecological and Human Health Impacts of Mercury in the Bay-Delta Watershed* – The project is in its third year. Two years of sampling and chemical analysis have been completed and a final report is in preparation.

5. System-Wide Ecosystem Benefits

The Delta is the heart of the watershed, where tributaries that drain 40% of the surface of California converge. This project would sample several of the main tributaries as they enter the Delta, providing not only an assessment of local conditions in the Delta but also an indication of the export of bioavailable mercury from upstream watersheds. The interdisciplinary, process-oriented studies proposed for the Delta would also benefit the entire system by advancing understanding of the conditions that lead to excessive mercury accumulation in food webs, as well as the conditions that do not lead to excessive accumulation.

The project will complement other past and ongoing studies of mercury contamination in sport fish (e.g., SRWP, TSMP, CALFED Mercury Project) and combine all of the data (graphs, maps, tables, accessible raw data) in a form that is readily used by managers.

C. Qualifications

The planned organization of the principal participants in this project is shown in Figure 5. Dr. Jay Davis of SFEI will be the principal investigator for the project, and will be assisted by SFEI staff in managing the project, and interpreting and reporting on the findings. Mark Stephenson of the San Jose State University Foundation will direct sport fish sample collection, sample processing, and mercury analysis. Gary Ichikawa of CDFG will direct the sport fish sample collection. Dr. Darell Slotton of U.C. Davis will direct the sampling and analysis of small fish. Dr. Maura Mack with the Environmental Health Investigations Branch (EHIB) of the California Department of Health Services will oversee and coordinate activities directed at local involvement and public outreach and education.

Dr. Jay Davis, San Francisco Estuary Institute, Principal Investigator

Dr. Davis has performed research on contaminant issues in the Bay-Delta for 15 years. The accumulation and effects of persistent, bioaccumulative toxicants has been an area of particular emphasis. Dr. Davis has been principal investigator on several studies of contaminant accumulation in fish, including the following.

1) The CALFED Mercury Project, a directed action evaluating many aspects of mercury contamination in the Delta region. Sampling was performed in 1999 and 2000, and the data are now being interpreted.

2) The fish contamination monitoring element of the Regional Monitoring Program (RMP) for San Francisco Bay, the sport fish monitoring program for the Bay. Dr. Davis has been involved since this monitoring began in 1997.

3) The fish contamination monitoring element of the Sacramento River Watershed Program. Dr. Davis has been involved since the onset of this program in 1997.

4) The Delta fish contamination study. This was a one time study in 1998 evaluating mercury and organochlorine contamination in sport fish in the Delta region.

5) Chronic Toxicity of Environmental Contaminants in Sacramento Splittail (*Pogonichthys macrolepidotus*): A Biomarker Approach. Dr. Davis is in charge of chemical analysis of splittail in support of this project. Field sampling is being performed in 2001 and 2002.

6) Coastal Intensive Site Network: San Pablo Bay. Dr. Davis is managing studies of mercury and accumulation in fish and avian eggs from San Pablo Bay and its marshes. Field sampling has been performed in 1999, 2000, and 2001.

In addition to the fish work, Dr. Davis is part of a team that manages the RMP, a $3 million/year program that monitors toxic chemicals in San Francisco Bay water, sediment, and biota. Drawing on his experience with all of these projects, Dr. Davis was lead author of the chapter "Mercury and Tidal Wetland Restoration" in the CALFED Whitepaper: "Ecological Processes in Tidal Wetlands of the Sacramento-San Joaquin Estuary and Their Implications for Proposed Restoration Efforts of the Ecosystem Restoration Program" (draft version awaiting final approval).

Mark Stephenson, San Jose State University Foundation

Mark Stephenson is the current principal investigator for the CALFED Mercury Project. This is an inter-disciplinary effort with 13 investigators with the goal to study mercury cycling in the Sacramento-San Joaquin Delta and Cache Creek and make recommendations to CALFED on how to lower the concentrations of mercury in sport fish. Mark has been the director of the Department of Fish and Game's Marine Pollution Studies research group for the past 10 years. He has been the principal investigator of several multi-million dollar grants. Mark's laboratory has been analyzing water for total mercury for 5 years and tissue and sediment for 21 years. Recent State Water Resources Control Board projects he has been principal investigator on include: California State Mussel Watch, Coastal Fish Contaminants, State Water Assessment and Monitoring Program, Impact of Mercury on Beneficial Uses in San Francisco Bay and the Central Valley Region, Mercury Monitoring in the Central Valley Region, and the Bay Protection Program. He has also been an investigator in the Sacramento River Watershed Program for the past 5 years.

Gary Ichikawa, California Department of Fish and Game

Mr. Ichikawa has managed and collected samples for various projects researching contaminant issues in the Bay-Delta for the last five years. These projects investigated the accumulation of contaminants in fish and clams, including the following.

1) The CALFED Mercury Project, an ERP directed action evaluating many aspects of mercury contamination in the Delta region. Sampling was performed in 1999 and 2000, and the data are now being interpreted. Mr. Ichikawa oversaw the collection of samples for this study.
2) The fish contamination monitoring element of the Sacramento River Watershed Program. Mr. Ichikawa oversaw the collection of samples since the onset of this program in 1997.
3) The Delta fish contamination study. This was a one time study in 1998 evaluating mercury and organochlorine contamination in sport fish in the Delta region. Mr. Ichikawa oversaw the collection of samples for this study.
4) Chronic Toxicity of Environmental Contaminants in Sacramento Splittail (Pogonichthys macrolepidotus): A Biomarker Approach. Field sampling is being performed in 2000, 2001 and 2002. Mr. Ichikawa is overseeing the collection of samples for this study.
5) The Toxic Substance Monitoring Program. From 1995-present, Mr. Ichikawa assisted in the collection of fish samples from the Bay-Delta region.

In addition to work in the Bay-Delta, Mr. Ichikawa has managed the State of California Coastal Fish Contamination Program from its inception in 1998 to the present. The Program collects over 800 fish per year for contamination evaluation. Mr. Ichikawa also manages the State of California Mussel Watch Program which utilizes mussels to evaluate contaminants in the bays and harbors of the State.

Dr. Darell Slotton, University of California Davis

Dr. Slotton has directed applied research projects addressing heavy metal contamination and bioaccumulation issues in California aquatic ecosystems for 15 years, with a primary focus on mercury. Since 1985, he has run a Hg biogeochemistry monitoring and research program at Davis Creek Reservoir and a Hg analytical laboratory at UC Davis. Between 1993 and 1998, Dr. Slotton led a research program throughout the foothill gold mining region of the Sierra Nevada, primarily focusing on benthic invertebrates and fish as proxies for relative bioavailable Hg concentrations and loading. He conducted an intensive, multi-year study of Hg mass loading, bioaccumulation, and remedial options at the Mt. Diablo Mercury Mine and Marsh Creek watershed, has led numerous mercury studies throughout the California Coast Ranges, and has been associated with the Clear Lake Superfund Hg Project since its inception. Recent projects have included Hg bioassessment and source identification studies in both lower Putah Creek and its mine-impacted upper watershed. Additional projects have investigated heavy metal biogeochemistry in other regions of the West and other areas of applied limnological and wildlife research. Since 1998, a primary focus has been to manage a CALFED-funded San Francisco Bay-Delta study of Hg source detection, bioaccumulation, and methylation, and the implications for wetlands restoration projects. Since 1999, he has also been the lead PI in a directed action CALFED project in the Cache Creek watershed, determining the patterns of localized Hg bioaccumulation, primary driving aqueous chemistry, sources, and the key forms of Hg minerals that dominate Hg methylation and movement into aquatic food webs.

Maura Mack, PhD, MPH, California Department of Health Services

Dr. Mack is chief of the Community Participation and Education Section in the Environmental Health Investigations Branch (EHIB) of the California Department of Health Services. She has extensive experience implementing environmental health outreach and education in diverse communities. In addition, in a previous position with the Idaho Division of Health, Dr. Mack developed an implementation strategy for the Idaho Fish Contamination Assessment, Monitoring and Consumption Advisories Project, in collaboration with colleagues from the Idaho Department of Fish and Game, Idaho Division of Environmental Quality, and U.S. Geological Survey.

Under the direction of Dr. Mack, EHIB will take the lead in coordinating local involvement with the proposed CALFED project, and implementing outreach and education in Delta communities, as necessary, based on fish sampling results. Of relevance to the CALFED project, EHIB has been actively involved in addressing consumption of contaminated fish in the Stockton, Los Angeles and San Francisco Bay areas, as follows:

1) During 1995-1998, EHIB conducted outreach and education to Asian and Pacific Islander populations consuming contaminated fish near the McCormick and Baxter Superfund site in the Port of Stockton. EHIB, together with local health agencies and community-based

organizations who served these populations, convened an interagency task force and posted translated warning signs, among other activities.

2) During 2000-2001, EHIB designed and implemented the Palos Verdes Shelf Outreach and Education Pilot Project in the Los Angeles area. This project utilized participatory approaches to advise local subsistence fishers and their families about the health risks of consuming fish contaminated with DDT. These approaches included the formation of an advisory group with broad representation from government agencies, fishing and environmental groups, and diverse ethnic communities; and the development of outreach materials in seven languages. Based on the success of the Palos Verdes Pilot Project, beginning in early 2002, EHIB will implement an expanded fish consumption education and outreach project in the Los Angeles area, with funding from the U.S. EPA.
3) EHIB recently completed the San Francisco Bay Seafood Consumption Study (SFEI, 2001). The study found that nearly two-thirds of people fishing in the Bay have no awareness or limited understanding of the State's advisory to limit consumption of Bay fish. To address some of the study recommendations, EHIB has received a grant from the U.S. EPA to implement the San Francisco Bay Fish Outreach and Education Project (September 2001-May 2002). This project uses an adaptation of the Palos Verdes Project model to broaden community involvement and strengthen local capacity to address outreach and education needs with respect to fish contamination issues in the San Francisco Bay Area.

D. Cost

1. Budget

The detailed labor and materials budget for each year is included in the web forms. For subcontract work under Task 6 (Stakeholder Coordination and Public Outreach) of this grant, Impact Assessment, Inc. (IAI), certified as a *bona fide* fiscal agent of the Department of Health Services, will be responsible for grant management including financial management, monitoring and reporting, personnel and benefits administration, consultant agreements and subcontracts, and purchasing and lease agreements. IAI is the principal support contractor for CDHS, is a state and federally recognized small business enterprise, and has assisted CDHS on the conduct of over 250 individual studies over the last six years.

2. Cost-Sharing

DHS/EHIB will contribute approximately $21,000 in staff support to this project in Year 1 and approximately $60,000 over 3 years.

E. Local Involvement

The DHS/EHIB mission is to protect the health of Californians by assessing the association between health outcomes and the environment, and collaborating with communities to address their environmental health concerns. Consistent with its mission, DHS/EHIB is keenly sensitive to the critical importance of

involving adversely impacted communities in the problem-assessment process. DHS/EHIB considers problem solving via a scientist-stakeholder partnership as the most effective means to an enduring solution.

Environmental health officials from the 5 Delta counties (Table 2) have expressed support for and willingness to participate in this project. In collaboration with these officials and SFEI, and in support of the CALFED project goal, EHIB will undertake the following activities to bring stakeholders fully into the process:

1) Create and convene a stakeholder advisory group, comprised of SFEI, EHIB, and other government agencies, representatives of Delta county health and environmental health departments and other local government agencies, local environmental groups, watershed groups, and angler groups, among others to be identified.
2) Engage stakeholders in discussions and quarterly meetings to alert them about mercury contamination in Delta sport fish and inform them about ongoing sampling efforts to further characterize contamination and assess health risks. Stakeholders will also be involved in developing, implementing and evaluating specific community-based outreach and education activities based on fish sampling results.
3) Educate county health departments about health risks from exposure to mercury, particularly among young children and women of childbearing age. The Outreach/Education Coordinator will (a) make presentations to appropriate health department staff on this issue; (b) conduct a needs assessment among target county health departments to identify their information and training needs on this issue; (c) develop and conduct training workshops based on the needs assessment , (d) identify collaboratively with county health departments communication strategies to inform residents of Delta communities about possible mercury contamination.
4) Involve stakeholders in developing, implementing and evaluating more specific community-based outreach and education activities based on fish sampling results.

F. Compliance with Standard Terms and Conditions

SFEI will be the primary contracting entity with CALFED. The standard terms and conditions are acceptable to SFEI.

G. Literature Cited

California State Department of Public Health. 1971. Mercury in the California environment: Compiled by the Interagency Committee on Environmental Mercury, July 1970- July 1971. California State Department of Public Health, Berkeley, CA.

Davis, J.A., M.D. May, G. Ichikawa, D. Crane. 2000a. Contaminant Concentrations in Fish from the Sacramento-San Joaquin Delta and Lower San Joaquin River, 1998. San Francisco Estuary Institute, Richmond, CA.

Davis, J.A., J.N. Collins, D. Yee, S. Schwarzbach, and S.N. Luoma. 2000b. Mercury and Tidal Wetland Restoration. Draft Chapter 6 in Brown, L. (ed.). DRAFT CALFED Whitepaper on:

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Davis, J.A., B.K. Greenfield, M. Stephenson, and G. Ichikawa. 2001. Mercury Concentrations in Sport Fish from the Delta Region: Progress Report on Task 2A of the CALFED Mercury Project. http://loer.tamug.tamu.edu/calfed/Reports.htm

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Tremblay, G., P. Legendre, J. Doyon, R. Verdon, and R.Schetagne. 1998. Use of polynomial regression with indicator variables for interpretation of mercury in fish data. Biogeochemistry 40: 189-201.

Table 1. Project timeline.

		YEAR 1				YEAR 2				YEAR 3				YEAR 4			
		Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
TASK 1	**PROJECT MANAGEMENT**																
1A	Subcontracting			X	X	X	X	X	X	X	X	X	X	X	X	X	
1B	Review and Prepare Invoices and Quarterly Reports			X	X	X	X	X	X	X	X	X	X	X	X	X	
1C	Project Coordination (Planning, Sampling Design, Meetings, Com			X	X	X	X	X	X	X	X	X	X	X	X	X	
1D	Peer Review coordination			X	X	X	X	X	X	X	X	X	X	X	X	X	
1E	QA Oversight					X	X	X	X	X	X	X	X	X	X	X	
1F	Data Mgmt/GIS/Web						X	X	X	X	X	X	X	X	X	X	
1G	Annual Report Production							X				X				X	
TASK 2	**SPORT FISH SAMPLING AND SAMPLE PROCESSING**																
2A	Sampling: DRSFMP			X	X			X	X			X	X				
2B	Sampling: Non-DRSFMP			X	X			X	X			X	X				
2C	Sample Processing			X	X			X	X			X	X				
TASK 3	**SPORT FISH CHEMICAL ANALYSIS**																
3A	Sport fish chemical analysis				X	X	X		X	X	X		X	X	X	X	
TASK 4	**SMALL FISH SAMPLING AND CHEMICAL ANALYSIS**																
4A	Small fish sampling and chemical analysis			X	X	X	X	X	X	X	X	X	X	X	X	X	
TASK 5	**DATA INTERPRETATION AND REPORTING**																
5A	Literature Review, Data Compilation and Analysis, Reporting, and Presentation							X	X	X	X	X	X	X	X	X	
TASK 6	**STAKEHOLDER COORDINATION AND PUBLIC OUTREACH**																
6A	Form Delta Regional Advisory Groups			X													
6B	Convene Advisory Group Meetings			X	X	X	X	X	X	X	X	X	X	X	X	X	
6C	Hold Planning Forum						X										
6D	Alert Stakeholders about Mercury Contamination of Sportfish			X													
6E	Obtain Stakeholder Input to Communications Strategies			X	X	X	X	X	X	X	X						
6F	Educate Local Health Departments about Health Risks from Exposure to Mercury			X	X												
6G	Conduct Needs Assessment with County Health Deaprtments, and Identify Communication Strategies			X	X												
6H	Build Capacity of Local Health Departments to Prevent Exposure to Mercury					X	X	X	X	X	X	X	X	X	X	X	
6I	Prepare Community Outreach/Education Implementation Plan				X												
6J	Implement Community Outreach/Education Activities					X	X	X	X	X	X	X	X	X	X	X	
6K	Evaluate Stakeholders Coordination and Public Outreach/Education Activities					X	X	X	X	X	X	X	X	X	X	X	

PROJECT BEGINS	SEP 2002
YEAR 1 SAMPLING BEGINS	SEP 2002
YEAR 1 SAMPLING ENDS	OCT 2002
YEAR 1 MERCURY ANALYSIS COMPLETED	JUNE 2003
YEAR 1 REPORT COMPLETED	AUG 2003
YEAR 2 SAMPLING BEGINS	SEP 2003
YEAR 2 SAMPLING ENDS	OCT 2003
YEAR 2 MERCURY ANALYSIS COMPLETED	JUNE 2004
YEAR 2 REPORT COMPLETED	AUG 2004
YEAR 3 SAMPLING BEGINS	SEP 2004
YEAR 3 SAMPLING ENDS	OCT 2004
YEAR 3 MERCURY ANALYSIS COMPLETED	JUNE 2005
YEAR 3 REPORT COMPLETED	AUG 2005
PROJECT ENDS	AUG 2005

Table 2. County Health Department contacts expressing support for this proposal.

County	**Contact**	**Title**
Contra Costa	Kenneth Stuart	Dir. Env. Health
Sacramento	Mel Knight	Dir. Env Health
San Joaquin	Donna Heran	Dir. Env. Health
Sutter	Jeff Williams	Dir. Env. Health
Yolo	Tom To	Dir. Env. Health

Figure 1. Average mercury concentrations in largemouth bass at CALFED Mercury Project sites in 1999.

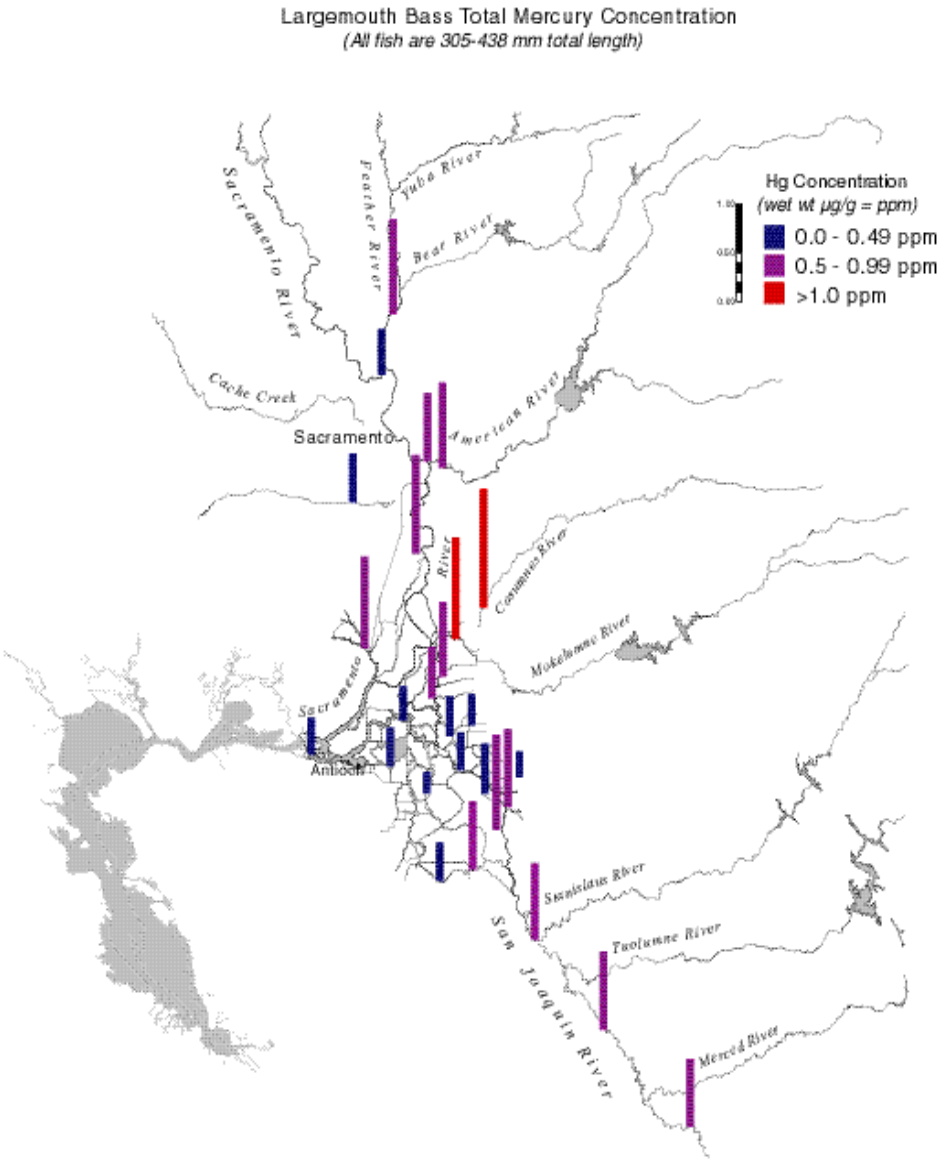


FIGURE 2

(From Slotton et al. 2001)
UC DAVIS DELTA CALFED PROJECT (CALFED Contract No 97-C05):
Effects of Wetland Restoration on the Production of
Methyl Mercury in the San Francisco Bay-Delta

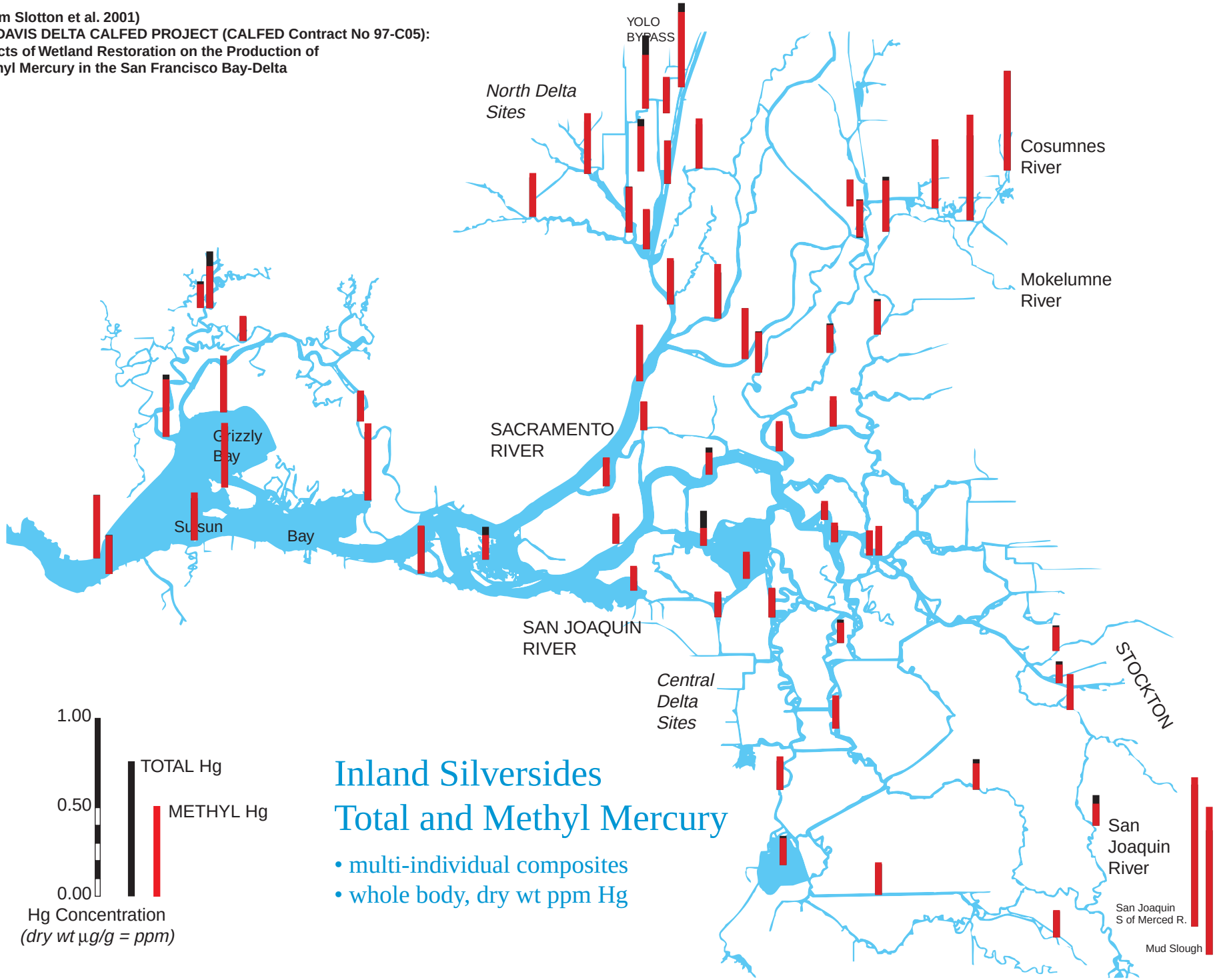


FIGURE 3

(From Slotton et al. 2001)
UC DAVIS DELTA CALFED PROJECT (CALFED Contract No 97-C05):
Effects of Wetland Restoration on the Production of
Methyl Mercury in the San Francisco Bay-Delta

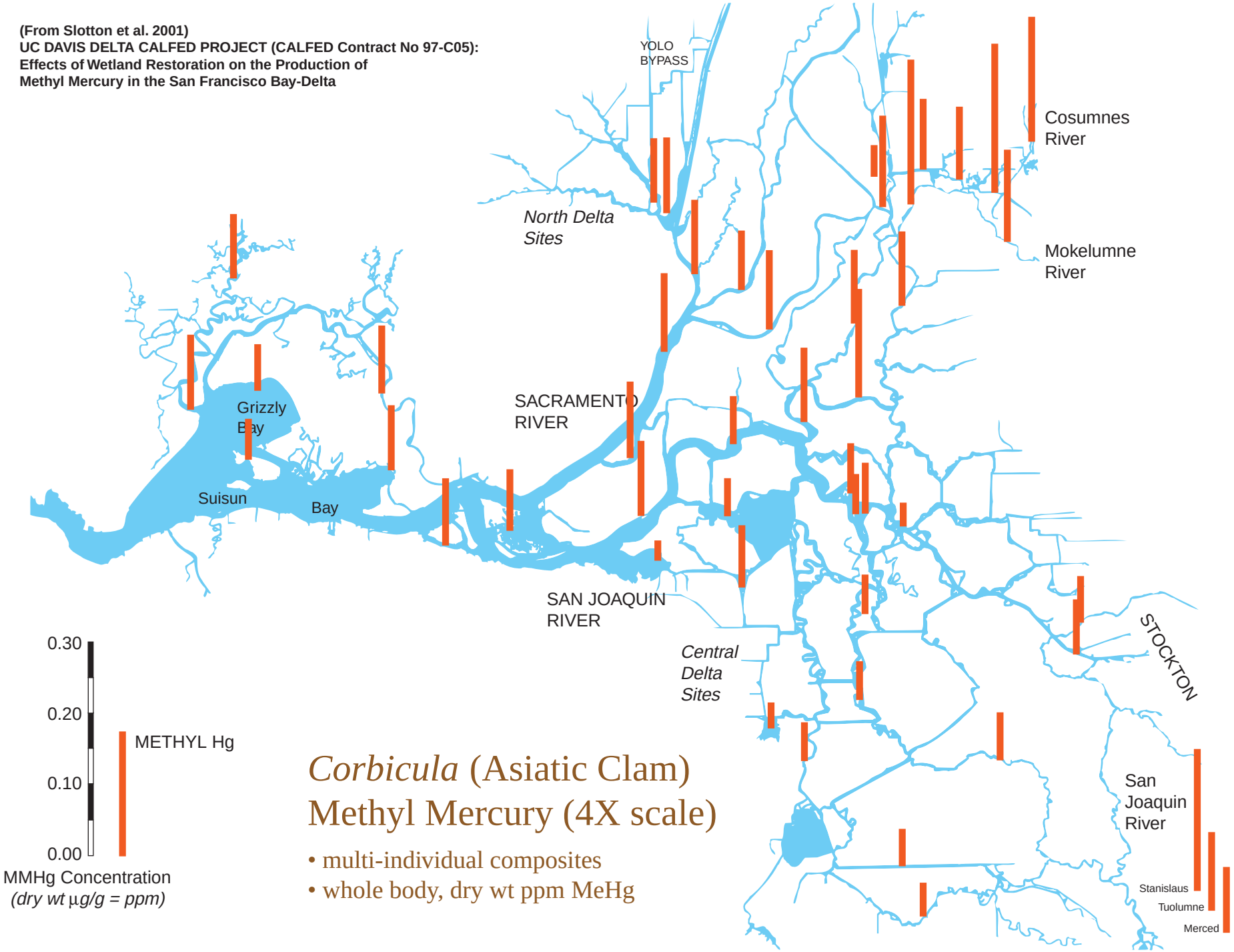


Figure 4. Delta Resident Shoreline Fish Monitoring Program blocks and candidate sampling sites.

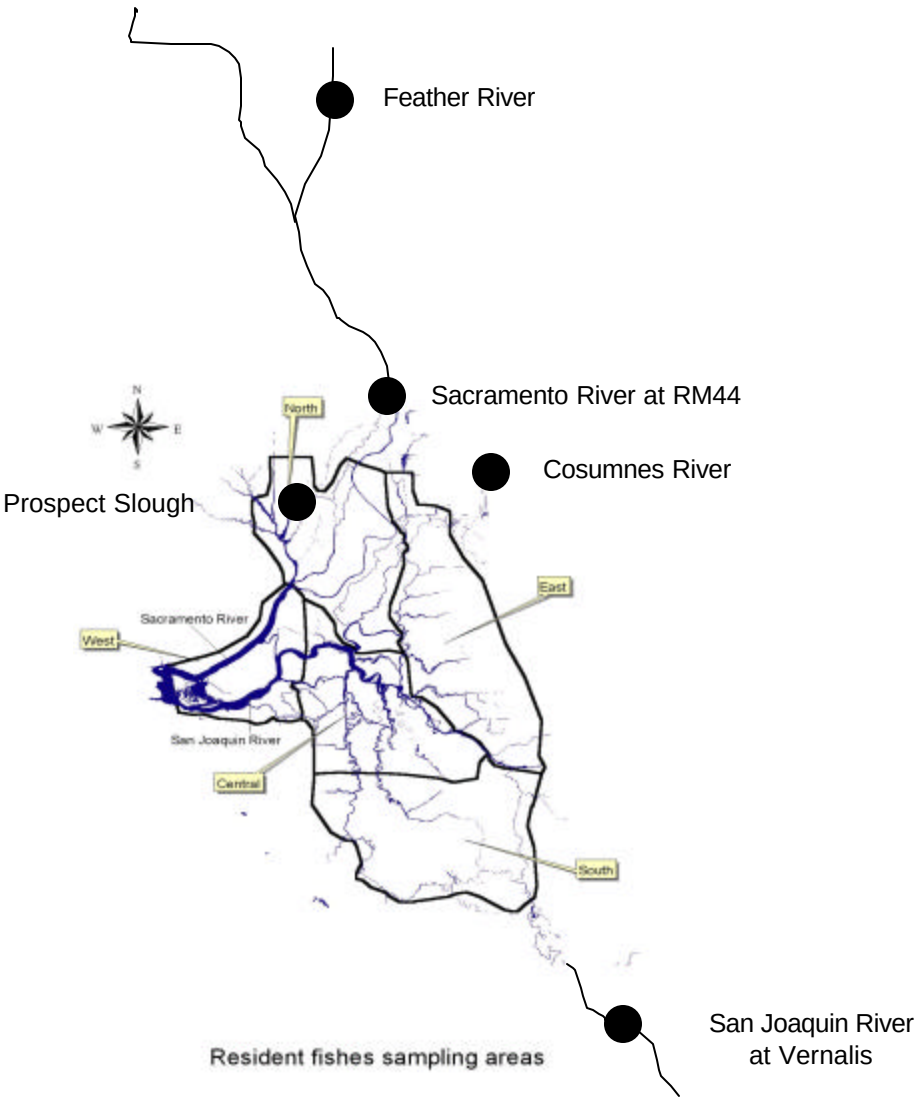
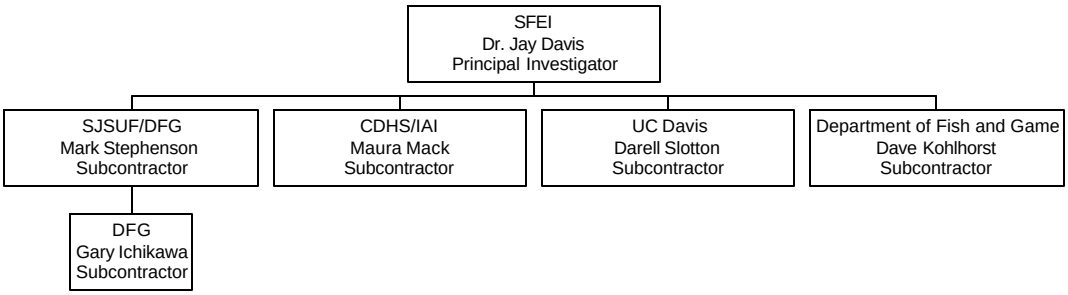


Figure 5. Organizational Chart



ATTACHMENT 1

Progress and Accomplishments on Task 2A (Mercury in Sport Fish of the Delta Region) of the ERP Directed Action "Assessment of the Ecological and Human Health Impacts of Mercury in the Bay-Delta Watershed"

Investigators: Jay Davis and Ben Greenfield, *San Francisco Estuary Institute*
Gary Ichikawa, Mark Stephenson, and staff, *Moss Landing Marine Lab*
Walter Jarman, *University of Utah*

Objectives

- Determine whether mercury occurs in sport fish at concentrations of potential human health concern and whether further consumption advice should be issued
- Firmly establish present mercury concentrations in sport fish as a basis for assessing long term trends
- Evaluate spatial patterns in mercury accumulation at high trophic levels in the Bay-Delta
- Evaluate key factors influencing mercury concentrations such as age/size and trophic position

Methods

Fish were collected from 26 locations in the Delta region in September and October 1999. The primary target species (largemouth bass, white catfish, and striped bass) were analyzed as individuals. Secondary target species (bluegill, Sacramento pikeminnow, redear sunfish, channel catfish, Sacramento sucker, brown bullhead, black crappie, and Sacramento blackfish) were analyzed as composites of 5 fish each. Target size ranges were established for all species following USEPA guidance (USEPA 1995). Length and weight of each fish were recorded. Largemouth bass ages were estimated by examining scales. Dissection and compositing of muscle tissue samples were performed following USEPA guidance (USEPA 1995). Total mercury was measured by Moss Landing Marine Lab. Stable isotopes of nitrogen and carbon were measured by the University of Utah.

After the initial analytical chemistry on these samples was completed, a large difference in mercury concentration was identified between 1998 data (generated by Moss Landing under a previous study) with the data from 1999. Because a large increase in fish tissue concentration over the course of one year seemed unlikely, the data and methodologies were re-evaluated. Two potential problems were identified: 1) The 1998 samples were digested by a different method than the 1999 samples and 2) The acid type and concentration used to make standards was different than the acid type and concentration of the 1999 samples that were analyzed. In order to address these issues, the 1999 samples were re-digested by the nitric/sulfuric digestion that was used for the 1999 samples, and the 1999 samples were re-analyzed using standards with 2.5% 70:30 nitric:sulfuric acid, identical to the samples.

The 1999 mercury samples were all redigested and analyzed in 36 batches. SRM (DORM-2 from the NRC) recoveries averaged 100%, and all 36 were within the 25% criterion established in the

QAPP. The mercury matrix spike recoveries averaged 104%, and all matrix spikes and matrix spike duplicates were within the 25% criterion in the QAPP. All of the mercury matrix spike RPDs and lab duplicate RPDs were below 25% and all method blanks were below the detection limit.

Preliminary Results/Conclusions

- 634 fish were collected and analyzed in 1999, establishing an extensive database on mercury in sport fish of the Delta region. 182 largemouth bass, 84 white catfish, and 34 striped bass were analyzed as individuals. Other species were analyzed as composites: these included black bullhead, bluegill, channel catfish, common carp, crappie, redear sunfish, Sacramento pikeminnow, and Sacramento sucker.
- Most of the legal size largemouth bass (141 of 172), white catfish (38 of 75), and striped bass (27 of 34) sampled were above the screening value (0.3 ppm) for mercury.
- Regional spatial patterns were observed, with elevated concentrations in the Sacramento and San Joaquin Rivers and a distinct drop in concentrations in the central Delta (Figure 1 in the Proposal). These data suggest that largemouth bass are a good indicator of spatial patterns in mercury in the food web.
- Statistically significant interannual variation was observed in largemouth bass, with higher mean concentrations in 1999 than in 1998 at 18 of 21 locations that were sampled in both years. A paired-sample sign test comparing 1999 and 1998 was significant at $p=0.001$. The 1999 results were an average of 35% higher than 1998. Paired 1998/1999 data for white catfish at 8 locations did not show a significant difference.
- Evaluation of influence of size, age, body condition, trophic position (stable nitrogen isotopes), and food source (stable carbon isotopes) are in progress. Sampling within the target size ranges effectively reduced variation due to size. For largemouth, 13 of 24 locations sampled showed a significant positive relationship of mercury and length. For white catfish, 3 of 12 locations showed a significant positive relationship.
- Comparison of recent striped bass data with historic data suggest that concentrations in the Bay-Delta have not changed much in 30 years.

Adjustments/Next Steps

- In 2000 we targeted smaller sizes of largemouth and white catfish and realigned sampling locations to exactly match locations being sampled by other investigators.
- The major sampling effort is finished.
- SFEI will complete analysis and interpretation of 1999 and 2000 data and will prepare a final report in December 2001.
- OEHHA will evaluate the data with respect to human health risks.

References

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ATTACHMENT 2

EFFECTS OF WETLAND RESTORATION ON THE PRODUCTION OF METHYL MERCURY IN THE SAN FRANCISCO BAY-DELTA SYSTEM
(CALFED Contract No. 97-C05)

THIRD YEAR PROGRESS BRIEF
August 18, 2001

Darell G. Slotton[a], Shaun M. Ayers[a], and Thomas H. Suchanek[b]
Ron Weyand[a], Anne Liston[a], Chance MacDonald[c], Douglas C. Nelson[c], and Brenda Johnson[b]

[a] Department of Environmental Science and Policy
[b] Department of Wildlife, Fish and Conservation Biology
[c] Section of Microbiology, Division of Biological Sciences

University of California, One Shields Ave., Davis, CA 95616

Summary of Task Objectives

Determine the potential relationship between wetlands restoration projects and methyl mercury (MeHg) production in the Sacramento-San Joaquin Delta. Utilize existing wetland tracts of varying ages (caused by breached levees) to identify the potential time sequence of MeHg production enhancement in this system. Determine the spatial patterns of net MeHg bioaccumulation throughout the Delta. Identify potential trends and possible driving variables.

Summary of Hypotheses

- Organic rich, vegetated wetland habitats in the Delta provide ideal environments for mercury (Hg) methylating microbes.

- These marsh environments produce MeHg at enhanced rates relative to other existing Delta aquatic habitats; a "new flooding" surge of methylation may also exist.

- Implementation of large Delta wetlands restoration projects might significantly increase the production and bioaccumulation of MeHg in the Delta, both locally and throughout.

- Historic deposition of Hg within the Delta is sufficient to maintain elevated concentrations of biotic MeHg.

Approaches/Methods

Field and laboratory approaches were developed to test net sediment mercury methylation and biotic mercury accumulation in the Sacramento-San Joaquin Delta. Relative sediment Hg methylation was first addressed by measuring direct efflux of MeHg from cores containing a variety of natural Delta sediments, but this was found to be problematic analytically. A second approach utilized a Hg-spiked slurry methylation potential technique. MeHg and total Hg (THg), and ratios of the two fractions, were assessed for various Delta sediments and, particularly, existing flooded tract and adjacent channel or mudflat control pairs. Localized net Hg bioaccumulation was investigated throughout the Delta. A variety of relatively sessile aquatic macrofauna were surveyed across the system and assessed for Hg concentrations. Some species were ubiquitous enough to be used as bioindicator tools to compare Hg concentrations between sites or regions. Localized sediment MeHg production potential and biotic accumulation results were evaluated against potential driving variables.

Discussion of Progress To Date / Results / Preliminary Conclusions

MeHg was analyzed by Battelle Marine Sciences Laboratory, Sequim, Washington. THg was analyzed in our UC Davis laboratories; QA/QC has been outstanding.

Sediment MeHg concentrations and MeHg:THg ratios were significantly greater in highly vegetated marsh habitats as compared to adjacent Delta channel and mudflat environments. Methylation potential experiments showed that flooded wetland sediments exhibited 2-30 times greater potential to produce MeHg than aquatic sediments of adjacent channels and flats.

However, biological findings to date indicate no discernible localized increase in net MeHg bioaccumulation in flooded wetland tracts vs adjacent aquatic habitats within Delta sub-regions. Some of the most well developed, highly vegetated wetland tracts exhibited *reduced* levels of localized net Hg bioaccumulation. These results suggest that wetland restoration projects may result in localized Hg bioaccumulation at levels similar to, but not necessarily greater than, levels within their surrounding Delta sub-region.

On a larger spatial scale, though, significant differences in bioaccumulation were identified across the Delta. Delta locales with elevated biotic mercury concentrations included areas fed by inflows from the Cosumnes River, Yolo Bypass and, to a lesser extent, Sacramento River. The Central and South Delta were markedly lower, despite high signals in some southern tributaries to the San Joaquin River and the presence of numerous flooded tracts in the Central Delta. An additional zone of elevated Hg bioaccumulation was identified in the West Delta between the Sacramento-San Joaquin confluence and Carquinez Strait, potentially resulting from historic mining depositional patterns and/or coincidence with the estuarine entrapment zone. Potential mechanisms for this apparent West Delta elevation in Hg bioaccumulation include elevated sulfate and organic material, supporting methylating microbes, and chemistry of the neutral form of inorganic Hg potentially being more readily transported across microbial membranes. Apart from the West Delta zone of elevated Hg bioaccumulation, the primary regions of elevated biotic Hg that were identified in this work can all be characterized as being dominated by

ongoing new inflows of Hg from upstream San Francisco Bay-Delta tributaries. Inputs of both elemental mercury from historic gold mining in the Sierra Nevada and abandoned mercury mine cinnabar in the Coast Range appear to be of importance. This suggests that upstream remediation efforts on either side of the watershed may be more meaningful than previously anticipated.

Inland silversides fish (*Menidia*) and Asiatic clams (*Corbicula*) within specific size classes were found to be the most ubiquitous and consistent measures of relative localized Hg bioaccumulation available throughout the system. Inorganic Hg and MeHg:THg ratios were highly variable in the bivalves, though MeHg was fairly consistent. Hg in silversides whole fish composites was found to consist entirely of MeHg (103% ± 17% of THg in 64 paired analyses).

Summer 2001 Update: In June 2001, we directly tested a wide cross section of flooded Delta tracts for potential net export of aqueous MeHg. This was accomplished with a series of tidal water collections, in which we sampled inflowing and subsequent outflowing tidal Delta waters during high amplitude tidal cycles. Samples representing initial/inflowing water were taken toward the end of inflowing (rising tide) cycles at prominent breaches of the targeted flooded tracts. Corresponding samples representing export from the flooded tracts were taken at the same locations toward the end of the subsequent outflowing (lowering tide) cycle. Standard clean sampling protocols were used for all collections. Because of recurring detection problems with filtered aqueous MeHg in the Delta (reported by other CALFED researchers), we tested an alternate approach, utilizing raw aqueous MeHg (preserved/fixed same day with ultra-clean hydrochloric acid) in conjunction with corresponding samples of total suspended solids (TSS). The results were both illuminating and promising as an ongoing sampling technique.

Inflowing/outflowing tidal sampling was conducted at eight important flooded Delta tracts and two integrating channel regions. At two large North Delta tracts with distinctly different habitats at either end (Liberty Island and Little Holland Tract), inflowing and outflowing water samples were taken from both the sand flat southern ends and the developed tule marshes at the northern ends. In nearly all sample pairs, taken throughout the Delta, outflowing aqueous MeHg was elevated over inflowing water. Taken alone, this data could suggest that the flooded Delta tracts may function as relative MeHg sources for their surrounding regions (and the Bay-Delta as a whole). In paired samplings from the North Delta export-integrating site at Lower Cache Slough, though reduced in absolute concentration, the MeHg level in outflowing water was double that of the inflowing tide. However, these apparent elevations in export water could be partially or largely a function of tidal flushing and associated sediment resuspension.

When the raw aqueous MeHg data are normalized to corresponding suspended particulate concentrations, a slightly different interpretation can be made. While strong relationships have been shown between TSS and total Hg in the Bay-Delta, the association between MeHg and particulates has not been clearly established for this system. By normalizing to TSS, we are not implying that all of the aqueous MeHg is associated with the corresponding particulates; we are simply factoring out the particulate load as the explanation for the variation in aqueous MeHg. Plotted in this way (as ng aqueous MeHg per gram TSS), the elevated MeHg in outflowing water at Lower Cache Slough

appears to be entirely a function of increased suspended solids in the outflowing water. The large sand flat expanses of Liberty Island and Little Holland Tract (and Mildred Island) demonstrated a net *decrease* in outflowing aqueous MeHg concentration when normalized to suspended solids. However, in virtually all of the tested flooded tract sites characterized by dense aquatic plant growth and organic-rich sediments, TSS-normalized aqueous MeHg was elevated in outflowing vs inflowing tidal water. This indicates that organic-rich wetland habitats may indeed be local and regional sources of aqueous MeHg. The most notable relative MeHg export occurred in the highly developed tule marsh habitat of representative site Mandeville Tip Island and the dense macrophyte beds of representative Little Franks Tract. The marshy northern ends of the North Delta tracts were also net export regions while the predominant sandflat habitats there were not.

These results contrast with the biotic data: within each Delta region, Hg bioaccumulation was typically similar in marsh, sand/mud flat, and channel/slough habitats. One possibility is that regional Hg bioavailability may be largely a function of methylation in flooded marsh zones, with this MeHg being subsequently distributed throughout adjacent aquatic habitats as a result of vigorous tidal mixing. However, the fact that the Central Delta, with a demonstrated high Hg methylating potential and the ability to export aqueous MeHg, was the lowest fish Hg bioaccumulation region of all indicates that several potentially competing processes may be involved in the dynamics of Hg bioaccumulation associated with flooded tracts.

In other developments, significant progress has been made in the analysis and interpretation of nitrogen and carbon stable isotopes in biological samples taken throughout the Delta. These data indicate some notable regional trends in carbon loading at the base of the food chain, which transfer trophically within regions. The analysis of nitrogen isotopic data continues in relation to the potential variation in relative trophic level of similar Hg bioindicator organisms from different locations. Stable isotope results (as well as all other project components) will be discussed fully in the final project report.

Potential for Future Research / Recommended Changes in Existing Research Program

The localized indicators developed in this work, particularly the inland silversides, *Corbicula* clams, and aqueous MeHg normalized to TSS constitute useful new monitoring tools that should be utilized into the future as new restoration projects and water diversion modifications are instituted. Further study is warranted on the potential role that wetland methylation may have on MeHg loading, both locally and for the Bay-Delta as a whole. Conversely, further study is warranted on the mechanisms resulting in apparent MeHg scavenging in organic-rich sites in the Central Delta, which would otherwise be expected to demonstrate elevated MeHg bioaccumulation.