MERCURY IN CENTRAL VALLEY SPORT FISH: DEFINING THE MERCURY PROBLEM

Project Information

1. **Proposal Title:**

   MERCURY IN CENTRAL VALLEY SPORT FISH: DEFINING THE MERCURY PROBLEM

2. **Proposal applicants:**

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

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:**

   Research

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:

   Longitude:

   Datum:

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

Samples could be collected from throughout the entire ERP geographic scope.

10. **Location - Ecozone:**

    Code 15: Landscape

11. **Location - County:**

    Alameda, Amador, Butte, Calaveras, Colusa, Contra Costa, El Dorado, Glenn, Lake, Lassen, Madera, Mariposa, Merced, Napa, Nevada, Placer, Plumas, Sacramento, San Benito, San Joaquin, Shasta, Sierra, Solano, Stanislaus, Sutter, Tehama, Tuolumne, Yolo, Yuba

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:**

    California 13th

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: $2116121

b) Do you have cost share partners already identified?

Yes

If yes, list partners and amount contributed by each:

California Department of Health Services $107,000

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

21. **Comments:**

Environmental Compliance Checklist

MERCURY IN CENTRAL VALLEY SPORT FISH: DEFINING THE MERCURY PROBLEM

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 a research project that will not adversely impact the environment, including protected species.

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?

      None

   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

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.**

California Department of Fish and Game personnel will collect the fish and are permitted to do so.

Land Use Checklist

MERCURY IN CENTRAL VALLEY SPORT FISH: DEFINING THE MERCURY PROBLEM

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).

   Research only

4. **Comments.**

Conflict of Interest Checklist

MERCURY IN CENTRAL VALLEY SPORT FISH: DEFINING THE MERCURY PROBLEM

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

Subcontractor(s):

Are specific subcontractors identified in this proposal? Yes

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

Mark Stephenson	San Jose State University Foundation
Gary Ichikawa	California Department of Fish and Game
Maura Mack	California Department of Health Services

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**

Comments:

Budget Summary

MERCURY IN CENTRAL VALLEY SPORT FISH: DEFINING THE MERCURY PROBLEM

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	936	26,568.96	4,952.45	2,000.00	0	20,000.00	0	0	53521.41	48,230.92	101752.33
2A	Fish sampling	0	0	0	0	0	234,716.00	0	0	234716.0	0	234716.00
2B	Sample Processing	0	0	0	0	0	36,801.76	0	0	36801.76	0	36801.76
3A	Mercury Analysis	0	0	0	0	0	222,611.00	0	0	222611.0	0	222611.00
4A	Data Analysis	600	16060	2993.58	0	2000	0	0	0	21053.58	29153.89	50207.47
4B	Landscape Attribute Analysis	160	3644.00	679.24	0	0	0	0	0	4323.24	6614.99	10938.23
5A	Stakeholder Coordination	160	4796.00	893.97	1000.00	0	199944.00	0	0	206633.97	8706.23	215340.20
		1856	51068.96	9519.24	3000.00	2000.00	714072.76	0.00	0.00	779660.96	92706.03	872366.99

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	1056	31,351.52	5,843.92	2,000.00	0	020,000.00	0	0	59195.44	56,912.75	116108.19
2A	Sampling	0	0	0	0	0	180,730.00	0	0	180730.0	0	180730.00
2B	Sample Processing	0	0	0	0	0	37,192.85	0	0	37192.85	0	37192.85
3A	Mercury Analysis	0	0	0	0	0	232,167.00	0	0	232167.0	0	232167.00
4A	Data Analysis	600	16864.00	3143.45	0	0	0	0	0	20007.45	30613.40	50620.85
4B	Landscape Attributes	160	3826.40	713.24	0	0	0	0	0	4539.64	6946.10	11485.74
5A	Stakeholder Coordination	160	5036.00	938.71	1000.00	0	193,738.00	0	0	200712.71	9141.90	209854.61
		1976	57077.92	10639.32	3000.00	0.00	663827.85	0.00	0.00	734545.09	103614.15	838159.24

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	1056	32,919.24	6,136.15	2,000.00	0	20,000.00	0	0	61055.39	59,758.65	120814.04
2A	Sampling	0	0	0	0	0	0	0	0	0.0	0	0.00
2B	Sample Processing	0	0	0	0	0	0	0	0	0.0	0	0.00
3A	Mercury Analysis	0	0	0	0	0	0	0	0	0.0	0	0.00
4A	Data analysis	600	17708.00	3300.77	0	0	0	0	0	21008.77	32145.52	53154.29
4B	Landscape Attributes	160	4017.60	748.88	0	0	0	0	0	4766.48	7293.19	12059.67
5A	Stakeholder Coordination	160	5288.00	985.68	1000.00	0	202694.00	0	0	209967.68	9599.36	219567.04
		1976	59932.84	11171.48	3000.00	0.00	222694.00	0.00	0.00	296798.32	108796.72	405595.04

Grand Total=2116121.27

Comments.

Budget Justification

MERCURY IN CENTRAL VALLEY SPORT FISH: DEFINING THE MERCURY PROBLEM

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

Year 1 Environ. Scientist II 580 Accountant 100 Contract Manager 56 Environ. Analyst 840 System Analyst 80 GIS Analyst 160 Graphics Designer 0 Year 2 Environ. Scientist II 660 Accountant 100 Contract Manager 56 Environ. Analyst 840 System Analyst 80 GIS Analyst 160 Graphics Designer 80 Year 3 Environ. Scientist II 660 Accountant 100 Contract Manager 56 Environ. Analyst 840 System Analyst 80 GIS Analyst 160 Graphics Designer 80

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

Hourly salaries 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.

18.64% 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.

$2000: Purchase of statistical software

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 SJSUF and DFG Staff Year 1: Labor (2570 hours); Salary - $38,854; Benefits $9,830; Travel - $12,500; Supplies - $7,000; Services - $81,824; Equipment - $48,000; Other Direct $6,500; Indirect - $30,208; TOTAL - $234,716 Year 2: Labor (2570 hours); Salary - $40,103; Benefits - $10,146; Travel - $13,000; Supplies - $7,000; Services - $85,915; Equipment - $5,000; Indirect - $19,565; TOTAL - $180,730 Year 3: No sampling Labor includes Project Assistant 2 at 131%, Project Assistant 1 at 9% 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. Maintenance and replacement of parts for boats. Services contracted to Dept. of Fish and Game ESIII, Gary Ichikawa and Jon Goetzl, for fish sampling. This contract contains funds for 50% of his salary at $31.13 per hour, plus $39,000 in travel, Overhead for DFG equals 15.3%, benefit rate equals 28%, other direct charge = overhead (26%) of first $25,000. Equipment: $48,000 for new electroshocking research vessel; $5,000 for backpack shocker; $10,000 for electroshocking motor Task 2B: Fish Sample Processing SJSUF Staff Year 1: Labor (712 hours); Salary - $9,256; Benefits - $2,342;

Supplies - $3,000; Indirect - $3,795; TOTAL - $18,393 Year 2: Labor (712 hours); Salary - $9,719; Benefits - $2,459; Supplies - $2,000; Indirect - $3,686; TOTAL - $17,864 Year 3: No sampling Supplies include laboratory items such as jars ,acid, teflon sheets, scalpels, gloves, instrument maintenance, equipment maintenance Task 3A: Mercury Analysis SJSUF Staff Year 1: Labor (8070 hours); Salary - $121,050; Benefits - $30,626; Supplies - $15,000; Services - $10,000; Indirect - $45,936; TOTAL - $222,611 Year 2: Labor (8070 hours); Salary - $127,102; Benefits - $32,157; Supplies - $15,000; Services - $10,000; Indirect - $47,907; TOTAL - $232,167 Year 3: No sampling 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 (100 samples) by an independent lab Task 5A: Stakeholder Coordinaton and Public Outreach Maura Mack California Department of Health Services/Environmental Health Investigations Year 1: Labor (3,224 hours) - $103,597; Travel - $16,450; Supplies - $29,700; Services - $20,000; Indirect Costs - $30,196 TOTAL - $199,944 Year 2: Labor (3,224 hours) - $109,679; Travel - $16,779; Supplies - $28,109; Services - $10,000; Indirect Costs - $29,171 TOTAL - $193,738 Year 3: Labor (3,224 hours) - $116,402; Travel - $17,115; Supplies - $28,527; Services - $10,000; Indirect Costs - $30,651 TOTAL - $202,694 Labor costs = 1.55 FTE each year. Positions are 1) Outreach and Education Coordinator (1 FTE); 2) Environmental Scientist (0.25 FTE); 3) Administrative Assistant (0.25 FTE); 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 and Scientist will travel by car to most of the counties in the Central Valley Region. Lodging, car rental, per diem, and mileage expense are included. These costs are subject to an increase of 2% each year for inflation. Supplies = in Year 1 include a laptop computer for use by the Coordinator, postage for mailings, educational materials, and Other Direct costs charged by the State for contract staff who use State facilities. In Years 2 and 3, these costs are again requested with the exception of the laptop computer. These costs are subject to an increase of 2% each year for inflation. Services = In Year 1 this category includes a year-end forum, translation and interpretation support, and advisory group expenses. In Years 2 and 3, these costs are again requested with the exception of the year-end forum. 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 the 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 $8,693.43 1C Project Coordination (Planning, Sampling Design, Meetings, Communication) $30,792.41 1D Peer Review coordination $27,132.06 1E QA Oversight $7,198.10 1F Data Mgmt/GIS/Web $16,108.38 1G Annual Report Production $0.00 Year 2 1A Subcontracting $12,419.88 1B Review and Prepare Invoices and Quarterly Reports $9,128.56 1C Project Coordination (Planning, Sampling Design, Meetings, Communication) $32,233.23 1D Peer Review coordination $27,488.67 1E QA Oversight $7,558.31 1F Data Mgmt/GIS/Web $16,912.84 1G Annual Report Production $10,366.71 Year 3 1A Subcontracting $13,040.03 1B Review and Prepare Invoices and Quarterly

Reports $9,584.58 1C Project Coordination (Planning, Sampling Design, Meetings, Communication) $33,746.09 1D Peer Review coordination $27,863.28 1E QA Oversight $7,936.52 1F Data Mgmt/GIS/Web $17,758.12 1G Annual Report Production $10,885.40

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.

Executive Summary

MERCURY IN CENTRAL VALLEY SPORT FISH: DEFINING THE MERCURY PROBLEM

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 have found mercury concentrations in sport fish that represent a human health concern, and suggest broad-scale contamination of the watershed with mercury. However, these studies have sampled only a fraction of the watershed. Very little effort has been made to identify local community concerns or needs regarding fish contamination issues. Outreach to these communities is the most rapid and effective means of reducing the impacts of mercury on human health. The goal of the proposed 3-year research project is to obtain a watershed-scale characterization of the spatial distribution of mercury in sport fish in the Delta watershed, including the entire area within the ERP Geographic Scope upstream of the Delta. The objectives of the project are: 1. Fill gaps in characterization of variation in the spatial distribution of mercury in sport fish. 2. Provide data that could supplement more detailed evaluations that may occur in the future of human health risks at contaminated sites. 3. Provide a foundation for evaluation of long term trends. 4. Identify landscape attributes that influence mercury accumulation in the food web. 5. Provide the opportunity for local community involvement in planning and disseminating sampling results. 6. Provide public education and outreach on mercury in sport fish. 7. Enhance local health department capacity to address public concerns about mercury in sport fish. The hypotheses to be evaluated are as follows: 1. Fish Hg concentrations in the watershed will vary spatially, ranging from safe to hazardous. 2. Elevated Hg in fish will be found downstream of historic mercury and gold mining activity. 3. Reservoirs are sites of mercury retention and methylmercury production. 4. Elevated Hg in fish will be found downstream of drainages with high percentages of wetland or floodplain acreage. Sampling will occur in years 1 and 2 and focus in particular on largemouth bass, which are broadly distributed in reservoirs and in the major rivers. A group of stakeholders will be formed and will provide input in sampling design and a channel for public outreach. 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 CENTRAL VALLEY SPORT FISH: DEFINING THE MERCURY PROBLEM

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

MERCURY IN CENTRAL VALLEY SPORT FISH: DEFINING THE MERCURY PROBLEM

A. Project Description: Project Goals and Scope of Work

1. Problem

Present concentrations of mercury in the Delta, the Bay, and the Sacramento and San Joaquin Rivers 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 first identified in 1969, as the scope of worldwide environmental contamination due to mercury was first being discovered, when two striped bass from the Delta were found to have 700 ng/g mercury in their muscle tissue. In 1970, as a result of this finding, an Interagency Committee was created to evaluate mercury contamination in California (California State Department of Public Health 1971). Many samples of sport fish collected in the Delta and its watershed were found to have mercury concentrations exceeding the 0.5 ppm tolerance level that applied at the time. In late 1970, based on these studies, a human health advisory was issued for the Delta advising pregnant women and children not to consume striped bass. The current advisory, issued in 1994, advises all anglers to limit consumption of striped bass and sturgeon (OEHHA 2001)

The State Water Resources Control Board's Toxic Substances Monitoring Program (TSMP), which began in 1978 and has continued to the present, was the next major program evaluating mercury in the region's freshwater sport fish (Rasmussen and Blethrow 1990). The TSMP has amassed a large database on mercury in sport fish throughout California, and has provided data used in the development of consumption advisories for several waterbodies in the Bay-Delta watershed, including Clear Lake, Lake Berryessa, Lake Herman, and the Guadalupe River watershed (OEHHA 2001). While the TSMP generated much useful information, the Program has not created a very clear picture of mercury contamination across the watershed. Spatial coverage of the watershed by the TSMP was patchy, continually shifting over time in an effort to discover hotspots. Due to budget and time constraints, samples collected at individual stations consisted of mixtures of species and composite samples with varying numbers and sizes of fish. In recent years, funding for the TSMP has tapered off.

More recent sampling in the watershed has employed methods recommended by USEPA (1995, 2000) that provide a firmer basis for evaluating human exposure to mercury through sport fish consumption. In these programs, a more determined effort was made to obtain target species at each location, to obtain uniform numbers of fish, and to adhere to narrow size ranges, resulting in datasets that can be readily compared among sites and over time. SFEI has conducted several of these programs, including: 1) the Regional Monitoring Program for San Francisco Bay, which began fish sampling in 1997 (SFEI 1999, Davis et al. in press) and is continuing on a three year

cycle; 2) the fish contamination monitoring element of the Sacramento River Watershed Program (Larry Walker Associates 2000, 2001), which began in 1997 and has continued to the present; 3) the Delta fish contamination study (Davis et al. 2000a), a one time study in 1998 evaluating contamination in sport fish in the Delta region; and 4) the CALFED Mercury Project (Davis et al. 2001) in which sport fish sampling in the Delta region was performed in 1999 and 2000 and the data are now being interpreted. Other recent studies that have provided data that are useful in evaluating human health concerns due to mercury in sport fish include the Lakes Study of the California Office of Environmental Health Hazard Assessment (OEHHA 1999), which examined mercury and other contaminants in Black Butte Reservoir and San Pablo Reservoir, and the Bear-Yuba Watersheds Interagency Abandoned Mine Lands Project, led by USGS (May et al. 2000), which sampled sport fish in reservoirs and streams in a historic gold mining region of the Sierra Nevada.

Each of these studies has found mercury concentrations in sport fish that represent a potential human health concern, especially to sensitive populations such as pregnant women and young children (U.S. EPA 2001a, 2001b). Mercury concentrations at many locations in the watershed have been found to exceed national health-based screening values by 2 to 3 fold (U.S. EPA 2000). Collectively, these recent studies begin to suggest broad-scale contamination of the watershed with mercury (e.g., Figure 1). However, these studies have sampled only a fraction of the watershed, and much of the watershed that could be expected to also have high mercury in sport fish has not been sampled with methods that would allow comparisons with other recent studies.

Fishing for food and recreation is a popular activity throughout the hundreds of reservoirs and lakes, and thousands of miles of rivers and streams in the watershed. However, very little effort has been made to identify local community concerns or needs regarding fish contamination issues. 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. Currently, the most effective way to reduce exposures to mercury through 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.

CALFED will create wetlands, floodplains, and reservoirs to increase habitat for priority fish species and increase water storage. There is a high probability that these actions will result in increased mercury accumulation in aquatic food webs and greater exposure to mercury by fishing populations. Prior to taking these actions, it is essential to precisely define the current extent of the mercury problem in order to provide a basis for evaluating CALFED's impact on it, to enable CALFED and the Regional Water Quality Control Board to develop a remediation strategy that focuses on the most practical and beneficial actions, and to understand which parts of the landscape are most prone to mercury accumulation.

Project Goal

Obtain a watershed-scale characterization of the spatial distribution of mercury in sport fish in the Delta watershed, including the entire area within the ERP Geographic Scope upstream of the Delta.

Objectives

1. *Fill gaps in characterization of variation in the spatial distribution of mercury in sport fish.*
2. *Provide data that could supplement more detailed evaluations that may occur in the future of human health risks at contaminated sites.*
3. *Provide a foundation for evaluation of long term trends.*
4. *Identify landscape attributes that influence mercury accumulation in the food web.*
5. *Provide the opportunity for local community involvement in planning and disseminating sampling results.*
6. *Provide public education and outreach on mercury in sport fish.*
7. *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. 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 ($CH3Hg^+$, 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 on both sides of the Valley indicate that both HgS and Hg^0 are reactive enough to be converted to methylmercury. Many areas in the watershed that are downstream of historic mercury and gold mines have not yet been sampled in a manner that would allow comparison with the growing body of data in the Delta region.

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 indicate possible 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, 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.

Methylmercury production appears to be the most important step in the mercury cycle with regard to food web accumulation, based on intensive studies in the Everglades and in Wisconsin lakes. These studies suggest that methylmercury production may generally determine the degree of contamination of aquatic food chains. Many factors influence methylmercury production. Total mercury concentration is one important factor. In many ecosystems, however, total mercury concentration alone is a poor predictor of methylmercury production and food web contamination. Some ecosystems with low total mercury concentrations in water and sediment, such as the lakes in northern Wisconsin and the Everglades, have high concentrations in piscivorous fish due to high rates of methylmercury production. Other ecosystems with high concentrations of total Hg may have low or moderate concentrations of methylmercury and bioaccumulation.

Other factors that influence methylmercury production can have an overriding influence on the degree of food web accumulation. Methylmercury production rates depend on the level of activity of methylating bacteria and the speciation of the mercury present, which determines the rate of mercury uptake by methylating bacteria. Mercury speciation and methylating bacteria activity in turn are influenced by several environmental factors, including redox potential, pH, salinity, dissolved organic carbon, concentrations of sulfur compounds, and temperature. Spatial patterns in these factors will be important in determining spatial patterns in methylmercury production and accumulation.

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. A number of 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 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.

Although progress has been made in recent years in understanding mercury cycling in aquatic ecosystems, understanding of these complex processes is still not sufficient to explain some of the spatial patterns that have been observed in the watershed, much less predict what the distribution is in areas that have not yet been sampled appropriately. For example, sampling performed in the CALFED Mercury Project (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 high concentrations surrounding this region.

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 the overall rate of decline is imperceptible on the scale of a few years.

Summary of Conceptual Models

- Elevated food web mercury in the watershed has been observed downstream of both mercury and gold mining regions, indicating that both elemental mercury and cinnabar are reactive enough in this watershed to lead to methylmercury production and that total mercury is an important predictor of mercury bioaccumulation. Many areas in the watershed that are downstream of historic mercury and gold mines have not yet been sampled in a manner that would allow comparison with the growing body of data in the Delta region.
- CALFED restoration activities will create habitats that can be expected to increase net methylmercury production in the watershed.
- Our conceptual understanding of mercury cycling is far from complete. Surprises can be expected if we characterize the distribution of mercury bioaccumulation in the watershed, and these surprises may lead to an improved conceptual model of mercury cycling and to discovery of ways to minimize mercury bioaccumulation associated with habitat restoration.
- Sport fish are essential indicators of mercury contamination, useful in characterizing contaminated food webs, human exposure, and spatial and temporal variability in the watershed.
- The response time of the watershed for mercury is probably centuries. While some interannual variation in mercury concentrations can be expected, the overall rate of decline in mercury concentrations can be expected to be imperceptible on the scale of a few years.

Further characterization of the spatial distribution of mercury bioaccumulation in the watershed, as proposed in this project, is an essential first step in tackling the mercury problem. This work would identify the areas with high concentrations, which will be useful for identifying sources and priorities for remediation and public education, and identifying landscape attributes that are associated with food web accumulation. This work would also identify areas in the watershed with low concentrations (e.g., the Central Delta), which may shed light on the importance of mercury sources (e.g., mining versus atmospheric deposition), may find regions where the fishing beneficial use is not impaired and management actions are not needed, and may provide clues for how to restore habitat without exacerbating the mercury problem.

Hypotheses and Means of Evaluation

1. *Fish Hg concentrations in the watershed will vary spatially, ranging from safe to hazardous.* Conduct sport fish sampling broadly in the watershed, tracing contamination upstream from areas with demonstrated contamination, and including areas not influenced by historic mining or known mercury sources except for atmospheric deposition.
2. *Elevated Hg in fish will be found downstream of historic mercury and gold mining activity.* Sample reservoirs, streams, and rivers downstream of historic mining regions.
3. *Reservoirs are sites of mercury retention and methylmercury production.* Sample reservoirs throughout the watershed.

4. *Elevated Hg in fish will be found downstream of drainages with high percentages of wetland or floodplain acreage.* Sample drainages in the watershed with varying degrees of wetland and floodplain acreage.

In evaluation of all of these hypotheses, this project will seek to sample areas not adequately covered by previous sampling efforts and to combine the data obtained in this study with data from other ongoing and past sampling efforts to create a comprehensive spatial assessment of mercury contamination in the watershed. Sampling will focus in particular on largemouth bass, which are broadly distributed in reservoirs and in the major rivers. Other species will also be targeted to obtain as clear a picture as possible of mercury bioaccumulation throughout the watershed.

Project Type

In the terminology of the Draft Implementation Plan and the adaptive management diagram in Chapter 2 of the Plan, this would be a targeted research project aimed at providing initial characterization of the mercury problem. With better definition of the problem it will be possible to optimally establish ecosystem goals for mercury remediation, improve conceptual models for mercury fate in the watershed, and provide a basis for reassessing the problem in the future. Not having this information may lead to flawed conceptual models, inefficient attempts to address the problem, and an inability to evaluate progress toward reducing mercury bioaccumulation.

The project would consist of two years of sampling. The sampling plan for the second year would be developed in an adaptive manner after evaluation of results from the preceding year. In this way, efforts can be strategically balanced between confirming and determining the boundaries of contaminated areas, sampling new areas, and generally adapting the sampling design to obtain the clearest possible evaluation of the project's hypotheses.

3. Approach

Study Design

The first step in designing the study will be to thoroughly review existing data on mercury in sport fish in the watershed. The Toxic Substances Monitoring Program (Rasmussen and Blethrow 1990) in particular has gathered a large amount of data on mercury throughout the State, but has not sought to standardize species, fish sizes, or sample numbers, making it difficult to compare data from different locations. Overlap with other programs, such as the Abandoned Mine Lands Project in the Bear and Yuba River Watersheds led by USGS (May et al. 2000), will be avoided.

The second step will be to identify sampling sites. Criteria to be considered in sampling site selection will include:

- input from local agencies, community groups, anglers, and others;
- the presence of largemouth bass and other target species;

- location downstream or upstream of historic mining activity or contaminated sites;
- amount of fishing activity;
- lack of coverage under past or present sampling programs; and
- location downstream of landscape features expected to affect mercury bioaccumulation.

Approximately 100 sites will be sampled each year in years 1 and 2 of the three year project. The overall goal is to obtain a thorough spatial characterization of the watershed, so the primary emphasis each year will be on sampling areas that have not yet been sampled. Given the slow response time of the watershed for mercury, we consider it reasonable to combine the data from the two years for a spatial assessment. With two years of sampling it will be possible to achieve a reasonably thorough spatial coverage of the watershed. In year 2 it is likely that it will be valuable to resample some sites to confirm unusual results, or to better define the extent of contamination in a local area, so an adaptive approach will be taken allowing evaluation of the previous years data prior to conducting further sampling.

Sampling and Analytical Chemistry

Target species will include largemouth bass, striped bass, white catfish, and other popular sport fish species selected to allow the best characterization of spatial pattern in the watershed. To provide data that can be used in subsequent human health risk evaluations (Objective 2), at each site we will collect five fish within a narrow 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 at sites sampled in this project (Objective 3), we will also collect additional fish above and below the target range in order to establish the size:Hg relationship. The fish will be analyzed individually for mercury.

Fish samples will be collected by Moss Landing Marine Laboratory (MLML) by electroshocking (with an e-boat), fyke nets, gill nets, or other methods. Samples will be collected in the summer of each year. Total length (longest length from tip of tail fin to tip of nose/mouth) 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.

Mercury concentrations in 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. 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), as well as a method duplicate and a matrix spike pair will be run with each set of samples. Splits of 5% of samples will be analyzed by an independent lab. In general, QA requirements will be the same as those established for the CALFED Mercury Project (Davis et al. 2001). 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 among-site comparisons of standard sized fish. Statistical techniques presently under development in the CALFED Mercury Project will be employed. Using GIS, data from this project will be compiled along with comparable data from other studies in the watershed to create map-based graphics of mercury distribution throughout the watershed. The data analysis component of this project will include a quantitative comparison of fish mercury concentrations from this study and other studies to landscape features of the surrounding region. Patterns of mercury distribution will be compared to patterns of land cover in order to evaluate project hypotheses 2 and 4 (see Section A.2.). Vegetation data from the California Analysis Project or other spatial coverages will be used to calculate abundance of wetlands within the upstream watershed of each sampling site. Data compiled by the Division of Mines and Geology will be used to determine total number of mines within the watershed upstream of each site. Relationships to other landscape attributes may also be explored. Statistical and graphical analysis will be conducted to evaluate whether proximity to mines, wetland abundance, or other land cover features are related to mercury concentrations.

Based on procedures developed in the RMP, a database will be created in a format that can be easily queried for interested users and that can readily be combined with other data from existing and future studies. Access to the data, maps, and reports prepared in this project will be provided through the SFEI website.

The compiled data on the distribution of mercury in sport fish in the watershed will provide managers with information that is essential to understanding the scope of the mercury problem in the watershed, identifying sources, and setting priorities for remediation. This project will provide an integrated evaluation of data from different studies in the watershed, and will result in the development of a data management framework that can continue to be used in the future as additional sampling is performed.

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, we consider it feasible to sample 100 sites each year. If necessary, DFG staff from the Water Pollution Control Lab (WPCL), which performs TSMP sampling and has sampled widely across the State, is available to assist in sample collection. WPCL can also assist in mercury analysis if necessary. The DFG staff that would perform the sampling have the permits needed to collect fish in the region.

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, though on a reduced scale. If a CALFED Mercury Science Review Panel is formed, peer review of this project would be integrated into that effort.

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

- *Complete subcontracts with MLML 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 reports*
- *Meet data quality objectives for chemical analysis*
- *Complete chemical analysis and QA/data report in May of each year*
- *Complete peer-reviewed interpretive project report on year one sampling*
- *Convene quarterly stakeholder group meetings*
- *Conduct local health department needs assessment and training*
- *Hold forum to plan year 2 sampling and community outreach activities*
- *Present findings at annual review meetings, other symposia, and at meetings of stakeholder groups*
- *Associate observed spatial variation with landscape attributes*
- *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 laboratory. 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 project report on year one sampling

- 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 Q2 of 2002. If funds were not available until Q3, then it would not be possible to do the background work necessary to develop a sampling design and have it peer reviewed prior to beginning sampling in the summer, and the project would have to wait until 2003. This would still be acceptable to SFEI, MLML, and DHS.

We consider the two years of sampling to be inseparable, as 200 is a minimal number of sites for a reasonably thorough characterization of mercury in sport fish in the watershed. One item that could conceivably be separated is Task 4B (Landscape Attribute Analysis), but this would make it impossible to meet objective 4 of the project (identify landscape attributes that influence mercury accumulation in the food web) and this would limit the contribution of the project to enhancing CALFED's ability to select locations for habitat restoration and water storage. Deleting Task 4B would reduce the project cost by $34,484. Task 5 (Stakeholder Coordination and Public Outreach) could be separated. This would make it impossible to meet objectives 5, 6, and 7, and would eliminate an element of the project that was emphasized in the PSP. Deleting Task 5 would reduce the project cost by $639,130.

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.

- Goal 4 is to "protect and/or restore functional habitat types in the Bay-Delta estuary and its watershed for ecological and public values such as supporting species and biotic communities, ecological processes, recreation, scientific research and aesthetics." The Implementation Plan recognizes that "…there are difficult choices ahead regarding the relative importance of restoring different habitat types on regional and local scales, and there is a pressing need to develop better tools to make these decisions." One of the criteria that should be included in the decision making process is whether the restoration project will improve or worsen the existing mercury problem. Knowledge of where mercury contamination exists and what landscape features it is associated with will help inform decisions on where restoration should occur.
- 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." Only through comprehensive sampling, as proposed by this project, can the potential toxic impacts to humans from contaminated fish be adequately characterized. Through active local community involvement and education these toxic impacts 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. Identifying and addressing environmental justice issues is one of the CALFED Program's broad commitments mentioned under Goal 6. A key environmental justice issue relating to mercury contamination in fish is that mercury is most harmful to those who are 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).

This project addresses 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.
- *Advance the scientific basis of regulatory activities.* Broad characterization of the mercury problem provides health agencies with information needed to determine whether advisories are needed and provides water quality agencies with information needed to prioritize remediation activities.
- *Coordinate and extend existing monitoring.* The proposed project would be coordinated with other existing monitoring activities, pursuing sources of bioavailable mercury suggested by

other programs and extending monitoring into regions that are currently not being adequately sampled.

- *Take advantage of existing data.* This project will complement past and present studies by sampling in areas that have not yet been appropriately sampled, by updating past findings, and by more thorough spatial characterization of previously identified problem areas.
- *Address environmental justice issues.* This project will address environmental justice issues by involving populations who may be adversely impacted by mercury contamination in fish.
- *Address landscape scale issues.* Mercury contamination in the Bay-Delta watershed is a landscape scale problem. This project would define the spatial extent of this problem across the landscape.

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 off mercury sources, loadings, factors affecting transformation and bioaccumulation across the watershed. Studies that would characterize these problems and where they overlap with restoration activities are needed… Data on the extent of the threat from specific sources is needed to evaluate the relative importance of different sources to support prioritization of remediation efforts."
- **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. Further work, particularly in the tributaries, is needed to identify sources of bioavailable mercury."
- **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 CALFFED 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 Bay-Delta watershed.

2. Relationship to Other Ecosystem Restoration Projects

This project would build on the findings of two prior ERP projects: 1) the CALFED Mercury Project (sport fish sampling element) (*ERP-99-B06*), and 2) *Effects of Wetlands Restoration on Methyl Hg Levels* by UC Davis (*ERP-97-C05*) that have documented distinct regional variation in mercury in the Delta.

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* We would coordinate with this project and sample the same sites where advantageous.
2) *An Assessment of Factors Affecting Bioaccumulation and Adverse Effects of Mercury to Birds of the Bay/Delta Watershed., PI: Steve Schwarzbach, USFWS* We would coordinate with this project and sample the same sites where advantageous.
3) *Mercury in Delta Fish: Establishing a Network for Long Term Study, 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* These two proposals would be coordinated to avoid overlap.

In general, this project would be coordinated with any other sport fish mercury sampling in the watershed to avoid overlap.

This project will establish a foundation for a future study of fish consumption in the Delta watershed. The need for such a study was stated in the Implementation Plan and PSP.

3. Request for Next Phase Funding

This proposal is not a request for next phase funding.

4. 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.

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.

5. System-Wide Ecosystem Benefits

This project would promote a system-wide understanding of the mercury problem in the watershed of the Delta. This broad understanding is needed in order to find the most cost-effective strategy for addressing the problem. The project will complement other past and ongoing studies of mercury contamination in sport fish (e.g., SRWP, TSMP, CALFED Mercury Project, USGS Interagency Abandoned Mines Project) by sampling in areas that have not recently been appropriately sampled and by combining these data with data from other studies in a form that is readily used by managers.

C. Qualifications and Organization

The planned organization of the principal participants in this project are shown in Figure 2. Dr. 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 SJSUF will direct sample collection, sample processing, and mercury analysis. Gary Ichikawa of DFG, working under Mark Stephenson, will direct the sample collection. Dr. 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, 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.
2) The fish contamination monitoring element of the Regional Monitoring Program (RMP) for San Francisco 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 accumulation of mercury and other chemicals 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.

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 Central Valley communities, as necessary, based on fish sampling results. Of relevance to the CALFED project, EHIB has been actively involving local communities in outreach and education around 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 5 (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 $40,000 of staff support to this project in year 1 and approximately $107,000 over the course of the three year project.

E. Local Involvement

The 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, EHIB is keenly sensitive to the critical importance of involving adversely impacted communities in the problem-assessment process. Concomitantly, EHIB considers problem solving via a scientist-stakeholder partnership as the most effective means to an enduring solution.

Environmental health officials from 20 counties (Table 2) have expressed support for and willingness to participate in this project. In collaboration with these officials and SFEI, EHIB will undertake the following activities to bring stakeholders fully into the process:

1) Create and convene a two-tiered stakeholder advisory group: (a) Central Advisory Group (CAG) comprised of SFEI, EHIB, and other state government agencies, and representatives of the regional advisory groups, among others to be identified; and (b) Regional Advisory Groups (RAG), representing four-five counties per group. RAG members will include representatives of Central Valley county health departments and other local government agencies, local environmental groups, watershed groups, and angler groups, among others to be identified. The CAG and RAGs will meet independently on a quarterly basis during Year 1 of project implementation, and jointly at a forum to be held between Years 1-2. The forum will bring together project scientific staff, stakeholders, and others to review the results of Year I sampling activities, and plan Year 2 sampling activities to meet project objectives. The forum will also allow stakeholders to discuss lessons learned from community

involvement and outreach activities conducted during Year 1, and plan Year 2 activities.

2) Alert stakeholders about possible mercury contamination of sportfish in Central Valley watersheds, and inform them of the initiative underway to characterize this contamination and assess health risks. The Outreach/Education Coordinator will disseminate this information to stakeholders during the first meeting of the CAG and RAGs, and identify collaboratively a strategy for communicating this information to their constituents.

3) Obtain stakeholder input in (a) developing the fish sampling plan, including identification of popular local fishing locations for subsequent fish sampling activities; and (b) identifying appropriate methods for disseminating sampling results to populations residing in the Central Valley, particularly sport fishers and their families. The Outreach/Education Coordinator will obtain this input via focus groups conducted with stakeholder groups, among other methods.

4) Educate county health departments about health risks from exposure to mercury from fish, particularly among young children and women of childbearing age. The Outreach/Education Coordinator will (a) make a presentation 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 implement a training workshop based on the needs assessment; and (d) identify collaboratively with county health departments communication strategies to inform residents of Central Valley communities about possible mercury contamination.

5) Involve stakeholders in developing, implementing and evaluating more specific community-based outreach and education activities based on fish sampling results. In collaboration with the CAG and RAGs, the Outreach/Education Coordinator will identify appropriate activities for implementation during Years 2-3 of project implementation.

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.

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Table 1. Project timeline.

		YEAR 1				YEAR 2				YEAR 3				2005
		Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1
TASK 1	**PROJECT MANAGEMENT**													
1A	Subcontracting		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
1C	Project Coordination (Planning, Sampling Design, Meetings, Comı		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
1E	QA Oversight		X	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	X	X
1G	Annual Report Production								X				X	X
TASK 2	**SAMPLING AND SAMPLE PROCESSING**													
2A	Sampling			X	X			X	X					
2B	Sample Processing			X	X			X	X					
TASK 3	**MERCURY ANALYSIS**													
3A	Mercury Analysis				X	X	X		X	X	X			
TASK 4	**DATA INTERPRETATION AND REPORTING**													
4A	Literature Review, Data Compilation and Analysis, Reporting, and Presentation		X	X	X	X	X	X	X	X	X	X	X	X
4B	Landscape Attribute Analysis		X	X	X	X	X	X	X	X	X	X	X	X
Task 5	**STAKEHOLDER COORDINATION AND PUBLIC OUTREACH**													
5A	Form Central and Regional Advisory Groups		X											
5B	Convene Advisory Group Meetings		X	X	X	X	X	X	X	X	X	X	X	X
5C	Hold Planning Forum						X							
5D	Alert Stakeholders about Mercury Contamination of Sportfish		X											
5E	Obtain Stakeholder Input to Fish Sampling Plan and Communications Strategies		X	X	X	X	X	X	X	X	X	X	X	X
5F	Educate Local Health Departments about Health Risks from Exposure to Mercury		X	X										
5G	Conduct Needs Assessment with County Health Deaprtments, and Identify Communication Strategies		X	X										
5H	Build Capacity of Local Health Departments to Prevent Exposure to Mercury				X	X	X	X	X	X	X	X	X	X
5I	Prepare Community Outreach/Education Implementation Plan			X										
5J	Implement Community Outreach/Education Activities				X	X	X	X	X	X	X	X	X	X
5K	Evaluate Stakeholders Coordination and Public Outreach/Education Activities				X	X	X	X	X	X	X	X	X	X

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

County	**Contact**	**Title**
Amador	Mike W. Israel	Dir. Env. Health
Butte	Tom Reed	Dir. Env. Health
	Craig Erickson (alt. Contact)	
Calaveras	Brian Moss	Dir. Env. Health
Colusa	Jaime Favilla	Dir. Env. Health
Contra Costa	Kenneth Stuart	Dir. Env. Health
Glenn	Don Holm	County Health Advisor
Mariposa	Dave Conway	Lead Env. Health Specialist
Merced	Jeff Palsgaard	Dir. Env. Health
Nevada	Tracy Gidel	Env. Program Manager, Hazardous Materials
Placer	Brad Banner	Dir. Env. Health
Plumas	Jerry Sipe	Dir. Env. Health
Sacramento	Mel Knight	Dir. Env Health
San Benito	Bob Shingai	Dir. Env. Health
San Joaquin	Donna Heran	Dir. Env. Health
Stanislaus	Sonia Herigfeld	Dir. Env. Health
Sutter	Jeff Williams	Dir. Env. Health
Tehama	Lee Mercer	Dir. Env. Health
Tuolumne	Walt Kruse	Dir. Env. Health
Yolo	Tom To	Dir. Env. Health
Yuba	Tej Maan	Dir. Env. Health

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

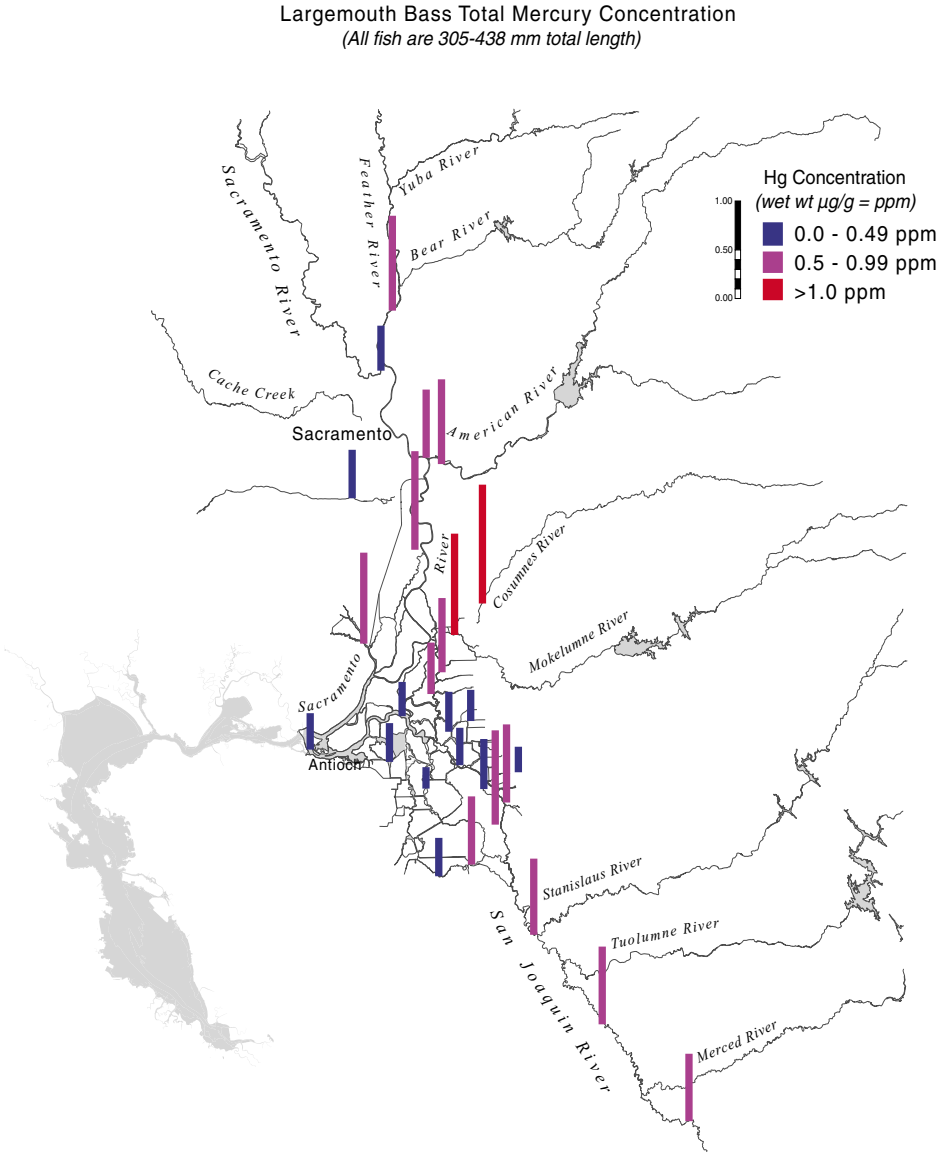

Figure 2. Organizational Chart