Ecosystem Restoration Program - 2002 Proposal Solicitation Package (PSP): Signature Page

Each applicant submitting a proposal to the CALFED Bay-Delta Program Ecosystem Restoration Program must submit a signed Signature Page.

Failure to sign and submit this form will result in the application not being considered for funding.

The individual signing below declares the following:

- the truthfulness of all representations in this proposal;
- the individual signing the form is authorized to submit the application on behalf of the applicant (if applicant is an entity or organization; and
- the applicant has read and understood the conflict of interest and confidentiality discussion in the PSP Section 2.4 and waives any and all rights to privacy and confidentiality of the proposal on behalf of the applicant, to the extent as provided in this PSP.

Proposal Title:

A PILOT PROGRAM FOR MONITORING, STAKEHOLDER INVOLVEMENT, AND RISK COMMUNICATION RELATING TO MERCURY IN FISH IN THE BAY-DELTA WATERSHED

_____
Authorized Signature

Jay Davis

_____
Printed Name

San Francisco Estuary Institute

_____
Organization

Ecosystem Restoration Program - 2002 Proposal Solicitation Package (PSP): Form I - Project Information

All applicants must complete this form for their proposals. ***Failure to answer these questions will result in the application not being considered for funding.***

1. Proposal Title:
A PILOT PROGRAM FOR MONITORING, STAKEHOLDER INVOLVEMENT, AND RISK COMMUNICATION RELATING TO MERCURY IN FISH IN THE BAY-DELTA WATERSHED

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, University of California Davis
Robert Smith, Robert Smith Associates
Don Stevens, Oregon State University

3. Corresponding Contact Person:

Jay Davis
San Francisco Estuary Institute
7770 Pardee Lane
Oakland, CA 94621
510 746 7368
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. If yes, is there an existing specific restoration plan for this site?

8. Topic Area

Ecosystem Water and Sediment Quality

9. Type of applicant

Private non-profit

10. Location – GIS coordinates

Latitude:
Longitude:
Datum: (leave blank)

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.

11. Location – Ecozone

Code 15: Landscape

12. 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

13. Location – City. Does your project fall within a city jurisdiction?

No

14. If yes, please list the city:

15. Location – Tribal Lands. Does your project fall on or adjacent to tribal lands?

No

16. Location – Congressional District.

California 13th

17. Location – California State Senate District & California Assembly District

California State Senate District Number: 9
California Assembly District Number: 16

18. How many years of funding are you requesting?

3

19. Requested Funds:

a. Are your overhead rates different depending on whether funds are state or federal?

No

b. If yes, list the different overhead rates and total requested funds.

c. If no, list single overhead rate and total requested funds.

0% (see Comments on Budget Form)

$4,323,004

d. Do you have cost share partners already identified?

Yes

If yes, list partners and amount contributed by each.

California Department of Health Services $93,029

e. Do you have potential cost share partners?

No

If yes, list partners and amount contributed by each.

f. Are you specifically seeking non-federal cost share funds through this solicitation?

No

If yes, list total non-federal funds requested.

g. If the total non-federal cost share funds requested above does not match the total state funds requested in 19a, please explain the difference.

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

No

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

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

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

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

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

No

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

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

No

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

No

If yes, identify project number(s), title, and funding source.

25. Please list suggested reviewers for your proposal. (optional)

Name	Organization	Phone	Email

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

26. Comments.

Ecosystem Restoration Program - 2002 Proposal Solicitation Package (PSP): Form II - Executive Summary

All applicants must complete this form for their proposals. *Failure to answer these questions will result in the application not being considered for funding.*

Proposal Title: A PILOT PROGRAM FOR MONITORING, STAKEHOLDER INVOLVEMENT, AND RISK COMMUNICATION RELATING TO MERCURY IN FISH IN THE BAY-DELTA WATERSHED

Please provide a brief but complete (about 300 words) summary description of the proposed project; its geographic location, project type, project objective, approach to implement the proposal, hypotheses and uncertainties, expected outcome and relationship to CALFED ERP and/or CVPIA goals.

Present concentrations of mercury in aquatic food webs in the Bay-Delta watershed are high enough to warrant concern for the health of humans and wildlife. Although fishing for food is a significant activity in the Bay-Delta watershed, there is low awareness among anglers about fish contamination issues and how to protect their health. CBDA restoration and water management activities may potentially lead to local and possibly regional increases in concentrations of mercury in aquatic food webs. On the other hand, remediation efforts by CBDA and other organizations will aim to reduce mercury accumulation in food webs.

To address mercury contamination of fish in the watershed, we propose a collaborative pilot program comprised of a three-pronged approach: monitoring of mercury in fish, stakeholder involvement, and risk communication. This approach follows the recommendations of the Mercury Strategy (Wiener et al. 2003) and builds on past and ongoing activities in the Bay-Delta watershed to address this issue. *Monitoring* of mercury in fish is the most relevant measure of mercury exposure in aquatic ecosystems. Monitoring will be an essential component of adaptive management of the mercury problem, allowing managers to identify and advance actions that reduce mercury exposure rather than increase it. For these reasons, a monitoring program for mercury in fish is a core component of the science program recommended in the Mercury Strategy (Wiener et al. 2003). Currently, very little monitoring is being performed in the watershed, and large portions of the watershed that are likely to have significant mercury contamination have not been sampled in an appropriate manner. *Stakeholder involvement* will ensure that the monitoring results will be relevant to local affected communities and will be integral to successful risk communication activities. *Risk communication* is the most effective way to reduce human exposure to mercury in the short-term.

This program will establish a foundation for state-of-the-science regional monitoring of mercury in the watershed coupled with stakeholder involvement and risk communication. This program – conducted in close coordination with other monitoring, research, restoration, remediation, and risk communication efforts in the watershed in an adaptive management approach - offers the best prospect for achieving short-term and long-term reductions in mercury exposure in the watershed.

Project Goals

1. *Protect human health by assessing and reducing exposure to methylmercury-contaminated fish through risk communication*
2. *Provide "performance measures" to gauge methylmercury contamination of the watershed during restoration and remediation*

3. *Establish an organizational and technical foundation for cost-effective, scientifically defensible monitoring of mercury in the watershed that meets the identified needs of end users and is coordinated with related science and management efforts*

Objectives

1. *Monitor spatiotemporal patterns of methylmercury in fishery resources in the watershed*
2. *Examine the relation of these patterns to ecosystem restoration, remediation, and landscape manipulations*
3. *Communicate health risks related to fish consumption to appropriate target audiences*
4. *Establish a Steering Committee and stakeholder advisory groups to facilitate 1) stakeholder input to the monitoring and risk communication activities and 2) coordination with other science and management efforts*

Sampling of mercury in sport fish and lower trophic level biosentinel fish species will be performed. The pilot monitoring program will include index sites for monitoring of temporal regional trends, intensive sites for detailed evaluation of health risks and food web dynamics, spatial characterization of sport fish contamination in the watershed, and development of protocols and monitoring of selected restoration and remediation sites. An organizational structure, including managers, scientists, and extensive local involvement, will be established to provide a lasting forum for communication. Inclusion of local involvement will provide a channel for risk communication.

Expected outcomes of the project include peer reviewed reports on results; newsletters and fact sheets; 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.

Significant changes from the last version of this proposal include: 1) the proposal is better integrated and has fewer objectives; 2) linkages to other CBDA efforts have been strengthened; 3) the addition of Don Stevens, an expert in design of environmental monitoring programs, and further elaboration of issues regarding sampling design; 4) sport fish will be sampled in only one year at each index site during this project; 5) increased emphasis on low mercury species in the proposed sampling design; 6) the schedule will allow ample time to set up the Steering Committee and obtain a fully-reviewed program prior to the onset of sampling in summer 2005; 7) lower total cost.

Ecosystem Restoration Program - 2002 Proposal Solicitation Package (PSP): Form III - Environmental Compliance Checklist

All applicants must complete this form for their proposals. *Failure to answer these questions will result in the application not being considered for funding.*

Successful applicants are responsible for complying with all applicable laws and regulations for their projects, including the National Environmental Policy Act (NEPA) and the California Environmental Quality Act (CEQA).

Any necessary NEPA or CEQA documents for an approved project must tier from the CALFED Programmatic Record of Decision and Programmatic EIS/EIR to avoid or minimize the projects adverse environmental impacts. Applicants are encouraged to review the Programmatic EIS/EIR and incorporate the applicable mitigation strategies from Appendix A of the Programmatic Record of Decision in developing their projects and the NEPA/CEQA documents for their projects.

1. **CEQA or NEPA Compliance**
   a. Will this project require compliance with CEQA? NO
   b. Will this project require compliance with NEPA? NO

   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). Please write out all words in the agency title other than United States (use the abbreviation US) or California (use the abbreviation CA). If not applicable, put None.**

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

   None

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

   CEQA

   ☐ Categorical Exemption
   ☐ Negative Declaration or Mitigated Negative Declaration
   ☐ EIR
   X ☒ none

NEPA

☐ Categorical Exclusion

☐ Environmental Assessment/FONSI

☐ EIS

X☉ none

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.

CEQA/NEPA Process

a. Is the CEQA/NEPA process complete?

NOT APPLICABLE

b. If the CEQA/NEPA process is not complete, please describe the dates for completing draft and/or final CEQA/NEPA documents.

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

4. **Environmental Permitting and Approvals**

Successful applicants must tier their project's permitting from the CALFED Record of Decision and attachments providing programmatic guidance on complying with the state and federal endangered species acts, the Coastal Zone Management Act, and sections 404 and 401 of the Clean Water Act. The CALFED Program will provide assistance with project permitting through its newly established permit clearing house.

Please indicate what permits or other approvals may be required for the activities contained in your proposal and also which have already been obtained. Please check all that apply. 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 AND 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:

Comments. If you have comments on any of the above questions, please enter the question number followed by a specific comment.

Ecosystem Restoration Program - 2002 Proposal Solicitation Package (PSP): Form IV - Land Use Checklist

All applicants must complete this form for their proposals. Failure to answer these questions will result in the application not being considered for funding.

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

NO

2. If you answered yes to #1, please answer the following questions:

a. How many acres will be acquired?

b. Will existing water rights be acquired?

c. Are any changes to water rights or delivery of water proposed?

d. If yes, please describe proposed changes.

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

YES: PUBLIC PROPERTY (BOAT LAUNCHES)

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

NO

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

MONITORING ONLY

5. If you answered yes to #3, please answer the following questions:

a. How many acres of land will be subject to a land use change under the proposal?

b. Describe what changes will occur on the land involved in the proposal.

c. List current and proposed land use, zoning and general plan designations of the area subject to a land use change under the proposal.

d. **Is the land currently under a Williamson Act contract?** *(For multiple sites, answer Yes if true for any parcel, and provide an explanation in the Comments box below)*

e. **Is the land mapped as Prime Farmland, Farmland of Statewide Importance, Unique Farmland or Farmland of Local Importance under the California Department of Conservation's Farmland Mapping and Monitoring Program?** For more information, contact the California Department of Conservation, Division of Land Resource Protection, Farmland Mapping and Monitoring Program (http://www.consrv.ca.gov/dlrp/FMMP/index.htm). (For multiple sites, answer Yes if true for any parcel, and provide an explanation in the Comments box below)

f. If yes, please list classification:

g. Describe what entity or organization will manage the property and provide operations and maintenance services.

6. Comments.

Ecosystem Restoration Program - 2002 Proposal Solicitation Package (PSP): Form V - Conflict of Interest Checklist

All applicants must complete this form for their proposals. *Failure to answer these questions will result in the application not being considered for funding.*

You may update your information at any time. The [update proposal] button is located at the bottom of this form.

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, University of California Davis

Subcontractor(s):

Are specific subcontractors identified in this proposal? YES

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

Gary Ichikawa	California Department of Fish and Game
Robert Smith	Robert Smith Associates
Don Stevens	Oregon State University

Helped with proposal development

Are there persons who helped with proposal development? YES

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

Chris Foe Central Valley Regional Water Quality Control Board

Ecosystem Restoration Program - 2002 Proposal Solicitation Package (PSP):
Form VI: Budget Summary

YEAR 1

YEAR 1

Task No.	Task Description	Direct Labor Hours	Labor Cost	Travel	Supplies and Expendables	Services or Consultants	Equipment	Other Direct Costs	Total Cost
1	Project Management	1582	$ 139,505	$ 3,000	$ -	$ 112,607	$ -	$ -	$ 255,113
2	Temporal Trend Monitoring	0	$ -	$ -	$ -	$ 404,913	$ -	$ -	$ 404,913
3	Spatial Characterization of Watershed	0	$ -	$ -	$ -	$ 242,091	$ -	$ -	$ 242,091
4	Restoration and Remediation Project Monitoring	0	$ -	$ -	$ -	$ 113,870	$ -	$ -	$ 113,870
5	Data Interpretation and Reporting	2120	$ 172,093	$ 3,000	$ 2,000	$ 52,439	$ -	$ -	$ 229,532
6	Stakeholder Involvement	160	$ 16,659	$ 1,000	$ -	$ 125,800	$ -	$ -	$ 143,459
7	Risk Communication	0	$ -	$ -	$ -	$ 58,188	$ -	$ -	$ 58,188
	TOTALS	3862	$ 328,257	$ 7,000	$ 2,000	$ 1,051,721	$ -	$ -	$ 1,447,167

Form VI: Budget Summary
YEAR 2

YEAR 2

Task No.	Task Description	Direct Labor Hours	Labor Cost	Travel	Supplies and Expendables	Services or Consultants	Equipment	Other Direct Costs	Total Cost
1	Project Management	1582	$ 146,481	$ 3,000	$ -	$ 112,607	$ -	$ -	$ 262,088
2	Temporal Trend Monitoring	0	$ -	$ -	$ -	$ 228,715	$ -	$ -	$ 228,715
3	Spatial Characterization of Watershed	0	$ -	$ -	$ -	$ 229,162	$ -	$ -	$ 229,162
4	Restoration and Remediation Project Monitoring	0	$ -	$ -	$ -	$ 117,570	$ -	$ -	$ 117,570
5	Data Interpretation and Reporting	2120	$ 180,698	$ 3,000	$ 2,000	$ 49,893	$ -	$ -	$ 235,590
6	Stakeholder Involvement	160	$ 17,492	$ 1,000	$ -	$ 149,364	$ -	$ -	$ 167,855
7	Risk Communication	0	$ -	$ -	$ -	$ 184,405	$ -	$ -	$ 184,405
	TOTALS	3862	$ 344,670	$ 7,000	$ 2,000	$ 887,311	$ -	$ -	$ 1,425,385

Form VI: Budget Summary

YEAR 3

YEAR 3

Task No.	Task Description	Direct Labor Hours	Labor Cost	Travel	Supplies and Expendables	Services or Consultants	Equipment	Other Direct Costs	Total Cost
1	Project Management	1582	$ 153,805	$ 3,000	$ -	$ 112,607	$ -	$ -	$ 269,412
2	Temporal Trend Monitoring	0	$ -	$ -	$ -	$ 183,656	$ -	$ -	$ 183,656
3	Spatial Characterization of Watershed	0	$ -	$ -	$ -	$ 266,218	$ -	$ -	$ 266,218
4	Restoration and Remediation Project Monitoring	0	$ -	$ -	$ -	$ 121,289	$ -	$ -	$ 121,289
5	Data Interpretation and Reporting	2120	$ 189,733	$ 3,000	$ 2,000	$ 51,389	$ -	$ -	$ 246,122
6	Stakeholder Involvement	160	$ 18,366	$ 1,000	$ -	$ 154,620	$ -	$ -	$ 173,987
7	Risk Communication	0	$ -	$ -	$ -	$ 189,768	$ -	$ -	$ 189,768
	TOTALS	3862	$ 361,903	$ 7,000	$ 2,000	$ 889,780	$ -	$ -	$ 1,450,451

GRAND TOTAL = $4,323,004

COMMENTS

This form is a slight variation from the format for the original PSP. This format was developed in consultation with the State Water Resources Control Board for a Central Valley monitoring project of similar scope: the Aquatic Pesticide Monitoring Program. This format is consistent with the way invoices will be submitted on the project. SFEI billing rates are generally lower than other private companies because SFEI is a non-profit institution.

Ecosystem Restoration Program - 2002 Proposal Solicitation Package (PSP): Form VII - Budget Justification

All applicants must complete this form for their proposals. ***Failure to answer these questions will result in the application not being considered for funding.***

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

	YEAR 1	YEAR 2	YEAR 3
Environ. Scientist II	632	632	632
Asst Environ Scientist	1560	1560	1560
Accountant	30	30	30
Contract Manager	30	30	30
Office Manager	30	30	30
System Analyst	120	120	120
GIS Analyst	280	280	280
Environ Analyst	540	540	540
Environ. Scientist I	480	480	480
Graphics Designer	160	160	160

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

	YEAR 1	YEAR 2	YEAR 3
Environ. Scientist II	44.93	47.17	49.53
Asst Environ Scientist	24.48	25.71	26.99
Accountant	25.75	27.03	28.38
Contract Manager	27.36	28.73	30.17
Office Manager	22.59	23.72	24.91
System Analyst	25.69	26.98	28.33
GIS Analyst	32.81	34.45	36.18
Environ Analyst	18.48	19.40	20.37
Environ. Scientist I	29.40	30.87	32.41
Graphics Designer	26.25	27.56	28.94

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.

Purchase of computers and statistical software: $6000

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 1: PROGRAM MANAGEMENT

Peer Review: $50,000 per year in years 1, 2, and 3 ($10,000 for travel and labor for each of 5 reviewers)

Statistical consultation: $23,000 per year in years 1, 2, and 3 for design and analysis (labor and travel)

Task 2: TEMPORAL TREND MONITORING

Sport fish sampling and chemistry SJSUF

Temporal Trend Monitoring

	LABOR HOURS	SALARY	BENEFITS	TRAVEL	SUPPLIES	CONSULTANT & SERVICES	EQUIPMENT	*OTHER* DIRECT	TOTAL DIRECT	INDIRECT	TOTAL COST
YEAR 1	4,540	$69,838	$25,488	$4,800	$14,600	$25,590	$65,000	$6,500	$201,678	$47,457	$255,635
YEAR 2	2,433	$37,522	$15,024	$4,600	$7,300	$23,650	$0	$0	$89,170	$17,718	$106,888
YEAR 3	1,334	$22,793	$9,245	$3,000	$5,700	$8,487	$0	$0	$47,218	$10,956	$58,174
TOTAL	8,307	$130,153	$49,758	$12,400	$27,600	$57,727	$65,000	$6,500	$338,067	$76,131	$420,697

Labor includes Project assistants at 134%. Overhead for DFG equals 19%, benefit rate equals 28%, other direct charge = overhead (26%) of first $25,000. Services includes $57,727 contracted to Gary Ichikawa for sampling fish (this contract contains funds for about 15% of his salary at a base of $60,984/year, plus $12,400 in travel) and for QA/QC splits. Travel expenses are for collection of samples. Supplies include fishing supplies (fishing gear, bait, nets, gloves and misc. pertaining to fishing, maintenance and replacement parts for boats), laboratory supplies, instrument maintenance. Equipment includes an inflatable boat, trailer, and 15 hp motor, 2- backpack shockers, $35,000 for purchase of Mercury Analyzer (Milestone DMA-80).

Biosentinel sampling and chemistry UC Davis

Year	Labor Hours	Salary	Benefits	Travel	Supplies	Service Contracts	Equipment	Total Direct	Indirect	TOTAL
1	2,912	$60,368	$21,129	$880	$2,200	$9,295	$31,000	$124,872	$24,407	$149,278
2	2,912	$62,179	$21,763	$906	$2,266	$9,574		$96,688	$25,139	$121,827
3	2,912	$64,044	$22,416	$934	$2,334	$9,861		$99,589	$25,893	$125,482
TOTAL	8,736	$186,591	$65,307	$2,720	$6,800	$28,730	$31,000	$321,148	$75,439	$396,587

LABOR	Labor costs = 1.4 FTE each year. Positions are 1) Principal Investigator (0.15 FTE); 2) Lab/Field/Data Manager (0.25 FTE); 3) Head Chemist (0.45 FTE); 4,5) Student Helpers (0.55 FTE). Benefits are included at 35% of salaries.
TRAVEL	Travel costs include mileage reimbursements for use of personal vehicles in sampling, launch fees, and boat fuel costs.
SUPPLIES	Includes supplies for field collections, sample handling and preparation, and laboratory analytical work.
SERV. CONTRACTS	Primarily charges to accomplish 5% QA/QC split sample analyses by outside laboratory. App. 12% for annual maintenance contract.
EQUIPMENT	Equipment budget to outfit a boat specialized for electroshocking small fish.
INDIRECT COSTS	No indirect costs for equipment. UC Davis standard off-campus indirect rate for all other direct costs = 26%.

Task 3 SPATIAL CHARACTERIZATION

Sport Fish Sampling and Chemistry SJSUF

Spatial Characterization

	LABOR HOURS	SALARY	BENEFITS	TRAVEL	SUPPLIES	CONSULTANT & SERVICES	EQUIPMENT	*OTHER* DIRECT	TOTAL DIRECT	INDIRECT	TOTAL COST
YEAR 1	6731	$101,082	$36,311	$6,600	$11,000	$46,072			$201,065	$41,026	$242,091
YEAR 2	6662	$90,437	$35,778	$6,600	$11,000	$47,436			$191,250	$37,912	$229,162
YEAR 3	6662	$110,378	$44,043	$6,600	$11,000	$49,107			$221,129	$45,090	$266,218
TOTAL	20055	$301,896	$116,133	$19,800	$33,000	$142,615			$613,444	$124,028	$737,472

Labor includes Project assistants at 323%. Overhead for DFG equals 19%, benefit rate equals 28%. Services includes $142,615 contracted to Gary Ichikawa for sampling fish (this contract contains funds for about 33% of his salary at a base of $60,984/year, plus $19,800 in travel) and for QA/QC splits. Travel expenses are for collection of samples. Supplies include fishing supplies (fishing gear, bait, nets, gloves and misc. pertaining to fishing, maintenance and replacement parts for boats), laboratory supplies, instrument maintenance.

Task 4 RESTORATION AND REMEDIATION PROJECT MONITORING

UC Davis Project Monitoring

Year	Labor Hours	Salary	Benefits	Travel	Supplies	Service Contracts	Equipment	Total Direct	Indirect	TOTAL
1	2,496	$49,392	$17,287	$720	$1,800	$7,605		$76,804	$19,969	$96,773
2	2,496	$50,874	$17,806	$742	$1,854	$7,833		$79,108	$20,568	$99,676
3	2,496	$52,400	$18,340	$764	$1,910	$8,068		$81,482	$21,185	$102,667
TOTAL	7,488	$152,666	$53,433	$2,225	$5,564	$23,506	$0	$237,394	$61,722	$299,117

LABOR	Labor costs = 1.2 FTE each year. Positions are 1) Principal Investigator (0.15 FTE); 2) Lab/Field/Data Manager (0.25 FTE); 3) Head Chemist (0.35 FTE); 4,5) Student Helpers (0.45 FTE). Benefits are included at 35% of salaries.
TRAVEL	Travel costs include mileage reimbursements for use of personal vehicles in sampling, launch fees, and boat fuel costs.
SUPPLIES	Includes supplies for field collections, sample handling and preparation, and laboratory analytical work.
SERV. CONTRACTS	Primarily charges to accomplish 5% QA/QC split sample analyses by outside laboratory. App. 12% for annual maintenance contract.
INDIRECT COSTS	No indirect costs for equipment. UC Davis standard off-campus indirect rate for all other direct costs = 26%.

SJSUF Project Monitoring Sport Fish

Project Monitoring Sport Fish

	LABOR HOURS	SALARY	BENEFITS	TRAVEL	SUPPLIES	CONSULTANT & SERVICES	EQUIPMENT	*OTHER* DIRECT	TOTAL DIRECT	INDIRECT	TOTAL COST
YEAR 1	457	$6,307	$2,250	$600	$1,750	$3,260	$0	$0	$14,167	$2,930	$17,097
YEAR 2	457	$6,622	$2,435	$600	$1,750	$3,423	$0	$0	$14,830	$3,064	$17,894
YEAR 3	457	$6,943	$2,552	$600	$1,750	$3,593	$0	$0	$15,439	$3,183	$18,622
TOTAL	1371	$19,873	$7,237	$1,800	$5,250	$10,276	$0	$0	$44,437	$9,177	$53,613

Labor includes Project assistants at 22%. Overhead for DFG equals 19%, benefit rate equals 28%. Services includes $10,276 contracted to Gary Ichikawa for sampling fish (this contract contains funds for about 3% of his salary at a base of $60,984/year, plus $1,800 in travel) and for QA/QC splits. Travel expenses are for collection of samples. Supplies include fishing supplies (fishing gear, bait, nets, gloves and misc. pertaining to fishing, maintenance and replacement parts for boats), laboratory supplies, instrument maintenance.

Task 5 INTERPRETATION AND REPORTING

UC Davis Interpretation and Reporting

Year	Labor Hours	Salary	Benefits	Travel	Supplies	Service Contracts	Equipment	Total Direct	Indirect	TOTAL
1	1,040	$27,440	$9,604	$400	$1,000		$4,000	$42,444	$9,995	$52,439
2	1,040	$28,263	$9,892	$412	$1,030			$39,597	$10,295	$49,893
3	1,040	$29,111	$10,189	$424	$1,061			$40,785	$10,604	$51,389
TOTAL	3,120	$84,814	$29,685	$1,236	$3,091	$0	$4,000	$122,827	$30,895	$153,721

LABOR	Labor costs = 0.5 FTE each year. Positions are 1) Principal Investigator (0.3 FTE); 2) Lab/Field/Data Manager (0.2 FTE). Benefits are included at 35% of salaries.
TRAVEL	Primarily related to project and scientific meetings, including lodging, fees, and mileage reimbursements for use of personal vehicles.
SUPPLIES	Includes office and reporting supplies such as computer software and hardware, photocopying, toner, etc.
EQUIPMENT	One computer and peripherals purchase to improve data manipulation and graphics capability.
INDIRECT COSTS	No indirect costs for equipment. UC Davis standard off-campus indirect rate for all other direct costs = 26%.

Task 6 STAKEHOLDER INVOLVEMENT

Year	Labor Hours	Salary	Benefits	Travel	Supplies	Services	Other Direct	Equipment	Indirect	TOTAL
1	1774	$64,255	$19,752	$3,235	$1,079	$5,250	$11,613		$20,616	$125,800
2	2114	$78,634	$24,172	$3,276	$1,312	$7,000	$10,493		$24,478	$149,364
3	2114	$81,779	$25,139	$3,323	$1,338	$7,000	$10,703		$25,339	$154,620
TOTAL	6002	$224,667	$69,063	$9,834	$3,729	$19,250	$32,809	$0	$70,433	$429,784

Labor costs for contract staff are 1.08 FTE in Year 1 and 1.29 FTE in Years 2 and 3. Positions are (1) two Health Educators (0.19 FTE in Year 1 and 0.41 FTE in Years 2 and 3); (2) Research Scientist (0.88 FTE in Year 1, and 0.85 FTE in Years 2 and 3); and (3) Health Program Manager (0.01 FTE in Year 1 and 0.02 FTE in Years 2 and 3). Benefits are included at 30.74% of salaries. Salaries and benefits are subject to an annual merit increase of up to 4%. Travel expenses (lodging, per diem, and mileage for car travel) for meetings, site visits, and conferences. Supplies include general office supplies and maps. Services include needs assessment support

(focus groups stipends and interpretation services), stakeholder advisory group support (travel stipends for community members), and a GIS/mapping consultant for compiling and displaying fishing activities data.

Other Direct Costs support contract staff who are housed in a State office building, i.e., rent, communications, and office automation. Indirect Costs cover general administrative activities required to execute the contact include financial management, project monitoring and reporting, personnel administration, secondary subcontract administration, consultant purchasing and lease agreement negotiation for Impact Assessment, Inc., EHIB's fiscal agent. The Indirect Cost rate is 19.6%.

Task 7 RISK COMMUNICATION

Year	Labor Hours	Salary	Benefits	Travel	Supplies	Services	Other Direct	Equipment	Indirect	TOTAL
1	780	$27,012	$8,304	$1,509	$474	$6,250	$5,103		$9,536	$58,188
2	2243	$79,589	$24,466	$4,807	$1,391	$32,800	$11,131		$30,220	$184,405
3	2243	$82,773	$25,444	$4,879	$1,419	$32,800	$11,354		$31,099	$189,768
TOTAL	5265	$189,374	$58,214	$11,195	$3,285	$71,850	$27,588	$0	$70,855	$432,361

Labor costs for contract staff are 0.47 FTE in Year 1 and 1.36 FTE in Years 2 and 3. Positions are (1) two Health Educators (0.31 FTE in Year 1 and 1.09 FTE in Years 2 and 3); (2) Research Scientist (0.12 FTE in Year 1, and 0.15 FTE in Years 2 and 3); (3) Health Program Manager (0.03 FTE in Year 1 and 0.08 FTE in Years 2 and 3); and (4) Graphic artist (0.02 FTE in Year 1 and 0.05 FTE in Years 2 and 3). Benefits are included at 30.74% of salaries. Salaries and benefits are subject to an annual merit increase of up to 4%. Travel expenses (lodging, per diem, and mileage for car travel) for meetings, trainings, and conferences. Supplies include general office and graphic artist supplies. Services include educational materials development and reproduction (e.g., posters, fact sheets, videos), translation support, training expenses, and mini-grants to community-based groups and local agencies for developing educational materials and activities, forum support (written materials, facility rental).

Other Direct Costs support contract staff who are housed in a State office building, i.e., rent, communications, and office automation. Indirect Costs cover general administrative activities required to execute the contact include financial management, project monitoring and reporting, personnel administration, secondary subcontract administration, consultant purchasing and lease agreement negotiation for Impact Assessment, Inc., EHIB's fiscal agent. The Indirect Cost rate is 19.6%.

NOTE: During the first 8 months of this project (11/04 to 6/05) we anticipate that the two Health Educator staff will be supported by CBDA funding from another project, Research, Outreach, and Education of Fish Contamination in the Sacramento-San Joaquin Delta Watershed, Phase 2 (AKA Delta Watershed Fish Project). These Health Educator staff will carry out activities under the Delta

Watershed Fish Project that duplicate subtasks 6.2 (conduct needs assessments), 6.3 (convene stakeholder advisory group), 7.3 develop messages and materials), and 7.4 (conduct trainings) of this proposal. As such, this proposal requests support for the Health Educator staff beginning on 7/05, and not for the first 8 months. Dr. Mack (the Health Program Manager) is a Co-Project Manager of the Delta Watershed Fish Project and her time on that project is contributed for the next fiscal year (7/04 to 6/05). After 7/05 we request support for her time on this project.

DHS/EHIB staff also make a significant contribution to this project. Three research scientist staff contribute 0.22 FTE to the project each year. The total value of contributed costs is approximately $93,000 over three years.

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 presentations, response to project specific questions and necessary costs directly associated with specific project oversight.

	YEAR 1	YEAR 2	YEAR 3
Contract and Financial Management	$ 54,507	$ 55,252	$ 56,035
Coordination	$ 88,056	$ 89,809	$ 91,649
Program Design	$ 53,622	$ 55,153	$ 56,760
QA Oversight	$ 17,245	$ 18,107	$ 19,013
Data Mgmt/GIS/Web	$ 41,683	$ 43,767	$ 45,955
TOTAL	$ 255,113	$ 262,088	$ 269,412

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. *[CORRECTION: If overhead costs are different for State and Federal funds, note the different overhead rates and corresponding total requested funds on Form I - Project Information, Question 17a. On Form VI - Budget Summary, fill out one detailed budget for each year of requested funds, indicating on the form whether you are presenting the indirect costs based on the Federal overhead rate or State overhead rate. Our assumption is that line items other than indirect costs will remain the same whether funds come from State or Federal sources. If this assumption is not true for your budget, provide an explanation on the Budget Justification form.]* Agencies should include any internal costs associated with the management of project funds.

Total labor costs are provided, which include costs of salary, benefits, rent, communications, office equipment, office supplies, administrative staff, administrative time, holiday, vacation, and sick time.

A PILOT PROGRAM FOR MONITORING, STAKEHOLDER INVOLVEMENT, AND RISK COMMUNICATION RELATING TO MERCURY IN FISH IN THE BAY-DELTA WATERSHED

A. PROGRAM DESCRIPTION: PROBLEM, GOALS, AND SCOPE OF WORK

1. PROBLEM

Present concentrations of mercury in aquatic food webs in the Bay-Delta watershed are high enough to warrant concern for the health of humans and wildlife. Recent sampling found that several commonly consumed fish species (including largemouth bass, striped bass, Sacramento pikeminnow, channel catfish, and white catfish) had mercury concentrations of high human health concern, exceeding the screening value (0.3 ppm) in a majority of samples and frequently exceeding 1 ppm (Figures 1 and 2) (Davis et al. 2003). These concentrations pose a serious problem because consumption of even small quantities of these fish (i.e., less than one meal per month of fish containing 1 ppm) may pose health risks to sensitive populations. Yet fishing for food and recreation remains a popular activity throughout the watershed. Nearly 10% of the California population engages in fishing activities (USDI 2003). Creel surveys by the California Department of Fish and Game (CDFG) estimated that anglers spent over 2.2 million hours per year fishing on the Sacramento River alone (CDFG 2001).

Although fishing for food is a significant activity in the Bay-Delta watershed, there is low awareness among anglers about fish contamination issues and how to protect their health. In 1998-1999, the Environmental Health Investigations Branch (EHIB) of the California Department of Health Services conducted the San Francisco Bay Seafood Consumption Study which found that about two-thirds of people fishing have no awareness or limited understanding of the existing San Francisco Bay fish advisory (SFEI 2000). The study also found that African-Americans and Asians catch, prepare, and eat San Francisco Bay fish in ways that are likely to increase their exposure to chemical contaminants. EHIB recently conducted a needs assessment in five counties in the watershed (Lake, Sacramento, San Joaquin, Placer, and Yolo) to determine fish contamination awareness, concerns, and information needs of stakeholders and members of affected communities (CDHS/EHIB 2004). Key findings include the following: (1) while county health and environmental health departments believe that local fish contamination is a public health concern, they are not undertaking public outreach and education activities, in large part due to competing public health needs that are a higher priority for these counties; and (2) members of Southeast Asian, Latino, African-American, and Russian communities regularly eat fish, especially striped bass and catfish, from local waters, and have generally low awareness of fish consumption advisories and the health risks of exposure to mercury in fish (Attachment 1).

Wildlife exposure is another facet of the mercury contamination problem. Recent studies indicate that mercury concentrations in eggs of several bird species are high enough to reduce hatching success (Schwarzbach and Adelsbach 2003). Mercury concentrations in the small fish that are preyed upon by piscivorous birds have been shown to vary widely, with several hotspots in the watershed (e.g., Slotton et al. 2002a, 2004a; see Attachment 2).

Mercury science is a rapidly developing field, and the Bay-Delta watershed represents a unique and challenging setting for mercury investigations. Mercury has a complex biogeochemical cycle that is only beginning to be understood in this ecosystem. Recent studies in the region (Davis et al. 2002, Slotton et al 2002a, 2004a, and others) have found striking regional variation in mercury bioaccumulation, and the causes of this variation are not well understood. Our present understanding of mercury is not sufficient to predict which restoration or remediation projects will affect mercury accumulation in food webs on a local or regional scale. CBDA restoration and water management activities may potentially lead to local and possibly regional increases in concentrations of mercury in aquatic food webs. On the other hand, remediation efforts by CBDA and other organizations will aim to reduce mercury accumulation in food webs. If reductions in mercury exposure at the regional scale are achieved, it seems likely that the rate of these reductions will be slow. The mercury problem in northern California was created in the 1800s by gold and mercury mining throughout the watershed (Figure 3), has persisted to the present, and is likely to persist for decades more.

To address mercury contamination of fish in the watershed, San Francisco Estuary Institute (SFEI), University of California at Davis (UC Davis), Moss Landing Marine Laboratory (MLML), and EHIB propose a collaborative pilot program comprised of a three-pronged approach: monitoring of mercury in fish, stakeholder involvement, and risk communication. This approach follows the recommendations of the Mercury Strategy (Wiener et al. 2003) and builds on past and ongoing activities in the Bay-Delta watershed to address this issue.

Monitoring of mercury in fish is the most relevant measure of mercury exposure in aquatic ecosystems. Monitoring will be an essential component of adaptive management of the mercury problem, allowing managers to identify and advance actions that reduce mercury exposure rather than increase it. For these reasons, a monitoring program for mercury in fish is a core component of the science program recommended in the Mercury Strategy (Wiener et al. 2003). Currently, very little monitoring is being performed in the watershed, and large portions of the watershed that are likely to have significant mercury contamination have not been sampled in an appropriate manner. Monitoring will also protect human health by identifying areas and species with both high and low levels of mercury. This information is needed to inform the public on ways to reduce mercury exposure while still enjoying the health benefits of wild-caught fish. The first step in adaptive management is clear definition of the problem, and the spatial boundaries of the mercury problem in the watershed have not yet been characterized.

Stakeholder involvement will be critical to the program's successful achievement of its objectives. The Mercury Strategy emphasized the importance of local representatives (beyond scientific and ecosystem management groups) providing input to the monitoring program, particularly on species and areas to be sampled. U.S.EPA, in *Fish Consumption and Environmental Justice* (2002), also concluded that participation by affected communities is crucial in the design of research programs to protect human health from contaminated fish. Stakeholder involvement will ensure that the monitoring results will be relevant to local affected communities. Stakeholder involvement is also integral to successful risk communication activities. The input of key stakeholders (i.e., county health and environmental health departments, Native American tribal organizations and members, and community-based

organizations and health care providers serving affected communities) will ensure that risk communication activities are responsive to local concerns, coordinated with ongoing programs, and build local capacity to reduce mercury exposure.

Risk communication is the most effective way to reduce human exposure to mercury in the short-term, particularly given the recalcitrance of mercury contamination in the watershed. Increasing public awareness of mercury contamination of fish and the health risk from mercury exposure is also an important element of the Mercury Strategy. Guided by results of the monitoring activities, risk communication activities will identify specific ways affected populations can reduce their exposure to mercury through selection of fishing locations or species that are less contaminated, or simply through reducing fish consumption. To be most effective, a variety of outreach, education, and training methods will be used to target sensitive populations and address the specific needs of Native American tribal organizations, and non-literate and non-English-speaking groups. Continuous process evaluation will ensure that risk communication activities are appropriate and effective in reducing exposure to mercury in affected populations.

In summary, this program will establish a foundation for state-of-the-science regional monitoring of mercury in the watershed coupled with stakeholder involvement and risk communication. This program – conducted in close coordination with other monitoring, research, restoration, remediation, and risk communication efforts in the watershed in an adaptive management approach - offers the best prospect for achieving short-term and long-term reductions in mercury exposure in the watershed.

Project Goals

1. *Protect human health by assessing and reducing exposure to methylmercury-contaminated fish through risk communication*
2. *Provide "performance measures" to gauge methylmercury contamination of the watershed during restoration and remediation*
3. *Establish an organizational and technical foundation for cost-effective, scientifically defensible monitoring of mercury in the watershed that meets the identified needs of end users and is coordinated with related science and management efforts*

Objectives

1. *Monitor spatiotemporal patterns of methylmercury in fishery resources in the watershed*
2. *Examine the relation of these patterns to ecosystem restoration, remediation, and landscape manipulations*
3. *Communicate health risks related to fish consumption to appropriate target audiences*
4. *Establish a Steering Committee and stakeholder advisory groups to facilitate*
   1) stakeholder input to the monitoring and risk communication activities and
   2) coordination with other science and management efforts

2. JUSTIFICATION

Conceptual Models Relating to Mercury Accumulation in the Watershed

The Mercury Strategy (Wiener et al. 2003) contains a strong recommendation for a mercury monitoring program, and includes a thorough discussion of the present understanding of mercury in the ecosystem and the conceptual rationale for this recommendation. Conceptual models relating to mercury in the watershed were also described in some detail in the original submittals of the three proposals that have been combined into this one. This proposal provides a condensed summary of the important points derived from conceptual models for mercury that pertain to the necessity and design of a pilot mercury monitoring program.

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.
- Striped bass are probably the most important indicator of mercury contamination in the region from a human health perspective, due to high mercury concentrations, their abundance, their great popularity for consumption, and the existence of historic data.
- Largemouth bass are a valuable indicator because they accumulate high concentrations, and are abundant, broadly distributed, popular with anglers, and generally nonmigratory.
- Low trophic level species (i.e., small fish and invertebrates) can provide the best statistical differentiation of spatial and temporal variability in methylmercury exposure (Attachment 2). They also provide representative data for prey items of piscivorous wildlife.
- Management actions of CBDA 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 food web mercury. The key to detecting real change in fish mercury will be filtering out extraneous interannual variation to reveal actual long term trends.
- 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 food web accumulation.
- Many areas in the watershed have not yet been sampled in a manner that would allow comparison with the growing body of high quality data in the Delta region (Figures 1 and 2), most notably many streams and reservoirs on the east side of the Valley draining Gold Country, including the watersheds of the American, Mokelumne, Stanislaus, Tuolumne, and Merced rivers. These drainages alone contain hundreds of reservoirs.
- The most effective way to reduce human exposure in the short term is to document patterns in levels of mercury in fish species in the Bay-Delta watershed and conduct activities to increase public awareness of the problem and provide guidance on ways to reduce exposure.

Hypotheses and Means of Evaluation

1. *Management actions will lead to localized 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 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.
3. *Elevated mercury in fish will be found downstream of historic mercury and gold mining activity.* Sample reservoirs, streams, and rivers downstream of historic mining regions.
4. *Elevated mercury 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.

Project Type This proposal describes a pilot regional program for monitoring mercury in fish, coupled with stakeholder involvement and risk communication with affected populations. A Steering Committee (SC), described below, will be formed with representation from appropriate stakeholders to provide a forum for ongoing communication between managers and scientists. Guidance and feedback from the SC will allow for ongoing adjustments to the program, as necessary, to meet management needs and ensure cost-effectiveness.

3. APPROACH

In this proposal we outline a plan for the Pilot Program that will serve as a starting point for SC discussion. We will follow the steps outlined in the Mercury Strategy. This is a large and complex project that is briefly summarized within this proposal. Short descriptions of the primary tasks are provided below.

Task 1: Program Management

Subtasks under this SFEI task include:

1.1 Contract and financial management;
1.2 Coordination;
1.3 Program design;
1.4 QA oversight; and
1.5 Data management.

This section focuses on discussion of Subtasks 1.2 (coordination) and 1.3 (program design). Data management is discussed below in Section 3.6 Data Handling and Storage. QA oversight consists of establishing a Quality Assurance Project Plan, reviewing results from subcontractors, and coordinating efforts to ensure comparability among subcontract labs (including coordination with the CBDA Mercury QA Program).

Developing an Organizational Framework for Stakeholder Guidance of the Program

The first step in implementing this proposal, as recommended in the Strategy, will be to establish a multidisciplinary, multi-institutional SC to lead and facilitate the program development process. Establishing this institutional structure will provide an important element of a lasting framework for adaptive management of the mercury problem over the long-term. The proposed membership of the SC is listed in Table 1, and includes representatives from the CBDA, water quality management agencies, health agencies, other major monitoring and research programs, environmental organizations, stakeholder advisory groups (SAGs), and major restoration projects.

The SC will provide a vital hub for coordinating fish mercury monitoring with other research, monitoring, and restoration activities in the watershed. Several elements of program coordination will be covered, including:

- Sampling design and quality assurance (to avoid duplication and promote generation of directly comparable data for the watershed);
- Sharing of results and information, including recent, unpublished findings; and
- Reporting of available data from the various programs.

With regard to reporting, a variety of informational products are proposed, including:

- an annual report that synthesizes data from this project and other projects and presents them in a concise, accessible format (similar to the "Pulse of the Estuary" – the annual report of the RMP);
- newsletters directed toward at-risk populations; and
- fact sheets targeted toward audiences (e.g., water quality managers, at-risk populations, restoration project managers) identified by the SC.

Attachment 3 provides details on how this project will be coordinated with other related efforts.

The SC will also provide a forum for local input and include representation from county health agencies and CBOs, among others, from throughout the CBDA solution area (described further under Task 6 below). Local SAGs will be represented on the SC to ensure stakeholder input. SC subcommittees will be formed as needed to address specific issues.

As described in the Strategy, a first step in implementing this proposal will be for the SC to refine the goals and objectives developed in the Strategy and incorporated into this proposal. Committee members will be carefully selected and guided to provide input to support the Program objectives. For example, the SC members will provide information on appropriate species and locations to monitor. The role of SC members will not be to bring unrelated objectives and priorities to the table. After the SC adopts refined goals and objectives, they will be peer reviewed, as recommended by the Mercury Strategy, and revised as appropriate.

Monitoring Component Design

Once the final goals and objectives are established, the next step will be to design a program to meet them. For developing this proposal, we had to devise preliminary plans. Preliminary plans for monitoring (and the other program components) will be presented to the SC for refinement.

The sampling design for fish monitoring will be developed in consultation with experts in the statistical design of monitoring programs and experts in fish monitoring. Two statisticians are on the team of investigators for this proposal. Dr. Robert Smith collaborated with Dr. Davis on implementing the polynomial regression ANCOVA technique employed for the sport fish data in the CALFED Mercury Project (Davis et al. 2003), and will work on applying this technique for evaluating spatiotemporal patterns in the data generated in this study and other comparable studies (especially Davis et al. [2003] and Slotton et al. [2002a, 2004a]). Dr. Smith will also perform power analyses needed to inform decisions about sampling design. Discussions of power analysis relating to the fish sampling are provided in Attachments 4 and 5. Dr. Don Stevens, another expert in statistical aspects of sampling design, will also be a co-investigator on this project. Dr. Stevens developed the spatially randomized and balanced, rotating panel design currently used by the RMP for sampling water and sediment in San Francisco Bay, and developed the statistical theory behind US EPA's EMAP sampling program. Dr. Stevens and Dr. Smith collaborated in a similar manner in developing the RMP sampling design.

Statistical analysis of recent reliable fish mercury data will be used as much as possible in crafting an efficient sampling design. Unfortunately, the sport fish element of the CALFED Mercury Project only collected one year of the data in the manner that should be followed in long term monitoring: based on a sampling of enough fish across a broad size range to support regression analysis (this design was developed in the second year of the Project) at each siteXtime combination. Furthermore, most sites were switched in year two of the Project. These false starts will be avoided in this proposed monitoring because of the groundwork established in the CALFED Mercury Project and the thorough process of design and review that will occur before sampling is conducted. Design of the biosentinel monitoring will utilize databases generated to date in related projects, primarily by the UC Davis team. These data will be examined, with the aid of the project statisticians, to better clarify issues regarding sampling design and power to detect spatial and temporal trends.

National experts in fish monitoring and risk communication will also be brought in to work with SC members on developing sampling designs and risk communication strategies. With statistical consultation, guidance from monitoring and risk communication experts, and SC input, robust strategies will be developed to meet the defined objectives.

An important consideration in site selection will be linking to process-oriented studies of mercury dynamics in water, sediment, and other portions of the food web. Linkage with these studies will support development of a mechanistic understanding of mercury uptake by key indicator species. Linkage with other types of research and monitoring projects, such as wetland monitoring or food web studies, may also lead to a better understanding of mercury cycling. A

list of the other efforts with which this pilot program will coordinate is provided in Table 2; details on coordination with these other efforts are provided in Attachment 3. Other criteria to be considered in site selection are described for each Program element below.

The next step, following Strategy recommendations, will be documentation of procedures for program tasks, including: fish sampling, handling and analysis of samples, quality assurance, archiving, data management, statistical analysis, synthesis and reporting, risk communication, outreach and education, and peer review. This documentation will facilitate the next step in the process, external peer review of the design of the program. A budget for peer review is included in this proposal. Peer review of this Pilot Program will be coordinated with any broader peer review of Strategy implementation. For review of the Pilot Program, a panel comprised of experts in fish mercury, monitoring, statistical sampling design, and risk communication will be assembled, with the guidance of the Steering Committee. This panel will provide initial review of the Pilot Program prior to sampling in 2005, and will meet annually to provide guidance on Program design and review of products emanating from the Program.

Task 2: Temporal Trend Monitoring

The preliminary design of the monitoring program includes five different types of sampling sites: index sites, intensive sites, striped bass sites, restoration sites, and spatial characterization sites (Tables 3 and 4). Tables 3 and 4 indicate which sites will be sampled in the different years of the project and how fish sampling will differ among sites.

Temporal trend monitoring will consist of three major elements: monitoring of index sites, intensive sites, and monitoring of striped bass. Striped bass monitoring is separated because this species is highly migratory and cannot reliably be collected at the same locations that are desirable for long term trend monitoring of other species.

Task 2.1. Index Site Monitoring

General Index Site Sampling Design. Index site monitoring will be conducted to provide information on health risks associated with fish consumption, long term regional trends, spatial variation, mechanisms of mercury uptake in indicator species, and factors influencing mercury accumulation in food webs. The index sites will be selected by the Steering Committee. The following draft selection criteria will be presented to the Committee:

- Popularity with local anglers;
- Integrative representation of subwatersheds;
- Spatial coverage of study area, especially regions where restoration and remediation are occurring;
- Existence of historic data at the location; and
- Linkage with other process and monitoring studies.

A list of candidate sites is given in Table 5 and locations of these sites (among others) are shown in Figure 5.

Approximately three sites will be sampled more intensely ("intensive sites") in 2005, 2006, and 2007. At the intensive sites, a concerted effort will be made to sample the entire spectrum of sport fish and lower trophic level fish species. This will provide valuable information on mercury concentrations in less common species and on how concentrations in the primary indicator species can generally be extrapolated to other species. Some information on interannual variation in sport fish mercury will be obtained through annual sampling at these sites to provide variance estimates needed for power analysis (see Attachment 4).

Biosentinel Sampling at Index Sites and Intensive Sites. Biosentinel sampling will be conducted with the objective of evaluating spatial and interannual trends in methylmercury exposure and bioaccumulation. Young-of-year small fish will be the primary monitoring tool, providing a responsive, integrative measure of bioaccumulation that can in turn be linked to mercury in large fish and wildlife and underlying measures of net methylmercury production and presence. At some tributary sites and sites directly within flooded tracts, small fish may be supplemented with benthic invertebrate sampling. Some examples of regional biosentinel results are presented in Attachment 2.

Small fish such as age 1 yellow perch have been established to be highly effective biosentinels of temporal and spatial variation in methylmercury exposure in work throughout the upper Midwest (e.g., Frost et al. 1999). In previous CBDA-funded research by UC Davis in the Cache Creek watershed, methylmercury in biosentinel small fish and aquatic insects was shown to correlate strongly with aqueous methylmercury concentrations, providing integrative measures of relative aqueous exposure (Attachment 2, Figure 2). That same Coast Range research and another recent CBDA project in the Yuba River watershed of the Sierra Nevada (Attachment 2, Figures 3-5) both found methylmercury in small fish and aquatic insects to be highly predictive of muscle mercury in co-occurring large fish of human health concern. UC Davis biosentinel monitoring has defined fine-scale seasonal cycles of biotic exposure and accumulation of methylmercury in Cache Creek, Davis Creek Reservoir (Slotton et al. 2002b), and an experimental wetland created in a former gravel mining region of Yolo County (Attachment 2, Figure 6). The utility of small fish and invertebrate biosentinels in defining spatial variation, as well as indicating mercury sources, has been established in CBDA research throughout the Delta and valley tributaries (Attachment 2, Figure 1), throughout the gold mining region of the Sierra Nevada (Slotton et al. 1995, 1997, 2003b), in relation to dredge tailings on the Merced (Attachment 2, Figure 8) and American Rivers (Attachment 2, Figure 7), and in relation to historic mercury mining throughout the Coast Ranges in numerous additional projects.

Establishment of a network of long-term biosentinel index sites will provide integrative measures of spatial and inter-annual variability, against which restoration monitoring, remediation monitoring, and mercury process studies can be calibrated. Index site monitoring will also provide a degree of regional and local performance measure monitoring.

Target biosentinel species: The primary biosentinel organism will be a small fish with the greatest convergence of key attributes, including:

1. wide and abundant presence throughout the CBDA region,
2. importance or dominance as a prey item of co-occurring piscivorous sport fish and wildlife,

3. relatively consistent and predictable diet and trophic level across the target sizes,
4. significant accumulation of methylmercury, allowing the differentiation of temporal and spatial variability, and
5. acceptable levels of individual variability in mercury bioaccumulation within same site-samplings.

A single sentinel species would be ideal to assess spatial and temporal variability across the entire CBDA study area. However, this area spans large gradients of habitat, water quality and, hence, species assemblages. Different characteristic species assemblages will require the use of alternate sentinel species in some of the regions. Preliminary work found the inland silverside (*Menidia beryllina*) to provide the greatest confluence of key attributes across the widest spatial extent within the Delta region and near-Delta river inflows (Slotton et al. 2002a, Attachment 2 Figure 1). The yellowfin goby (*Acanthogobius flavimanus*) was found to be a potentially ideal sentinel species throughout the western extent of the Delta across a salinity gradient. These two species have been documented to constitute the primary small fish prey of co-occurring piscivorous fish throughout much of the Estuary (Nobriga et al. 2002). That research also concluded that the diets of predatory fishes across the Estuary are closely linked to relative abundance of the prey items. Thus, the dominant small fish (and macro-invertebrate) available for biosentinel sampling will typically represent a key food item of co-occurring predatory fish. This is critical, as the chaotic nature of species invasions in this watershed makes it likely that the dominant available biosentinel species could shift over time. Additionally, prior CBDA research throughout the Delta region found spatial trends in mercury bioaccumulation to be consistent across numerous alternate small fish (and macroinvertebrate) species. In addition to demonstrating the feasibility of switching sentinel species if necessary, this finding of consistent spatial mercury trends among numerous sentinel species showed that the spatial trends observed were real, and not a function of varying relative trophic level in same species between sites. At each index site, biosentinel sampling will consist of collections of the appropriate, regionally dominant small fish, together with several additional small fish species as present. If appropriate small fish are not available at some of the locations, clams, crayfish, and/or caddisflies may be taken. A summary of the proposed sampling scheme is presented in Table 4.

Replication: Biosentinel sampling will emphasize the generation of consistent, tight statistical confidence intervals for each mean biotic mercury concentration, thereby facilitating the statistical differentiation of spatial and temporal variation. The number of replicates needed for each sampling is directly linked to the inherent variability in methylmercury bioaccumulation among individuals of the given biosentinel species. Work with age 1 yellow perch in the upper Midwest indicated that 30 replicate individuals provided a statistically robust sample (e.g., Frost et al. 1999). We undertook an analysis of replication and associated statistical confidence with small fish biosentinel data from several recent projects (see Attachment 5, Table 1). For a range of small fish species, both in the Estuary and in the tributaries, 15 replicate individuals were sometimes insufficient to provide statistical separation of environmental differences of 25% or less (the proposed statistical goal of the biosentinel sampling). An initial analysis of the primary target species, inland silverside, indicated that individual variability at some sites required as many as 25 replicates in order to statistically differentiate this level of environmental differences. Based on this information and additional statistical examination of the topic with techniques such

as Monte Carlo analysis, our biosentinel protocol will include, as available, up to 30 replicate whole individual small fish within a consistent size range for each sample, to be analyzed individually for total mercury. The methyl:total mercury ratio will be established as necessary for each species using composite samples. Prior work has established methyl:total mercury ratios in candidate small fish species to be consistently in excess of 90% in whole body samples. This has led to the Mercury Strategy suggesting the use of (less expensive) total mercury analyses for monitoring. It has also been established that small fish whole body Hg concentrations are generally similar to or greater than corresponding sediments throughout the study area, negating the concern of significant potential alteration of analytical results due to potential sediment ingestion. Any invertebrates utilized for monitoring will be analyzed for both methyl and total mercury. Because of the very large number of biosentinel samples to be generated by the overall project, three sampling approaches will be used. The primary index species will be sampled with extensive replication of individuals (n = up to 30, above). A second prevalent species will be sampled in replicate composites, each consisting of multiple individuals. This technique will provide a level of statistical confidence while generating a reduced analytical load. Additional species, as available, will be characterized with single multi-individual composites. Statistical confidence of samples analyzed as single multi-individual composites will be estimated with new investigations testing replication statistics as a function of individual analyses (including the initial approach as shown for silversides in Attachment 5; see "Protocol Development below). These statistical power analyses will be conducted in close consultation with Dr. Robert Smith of the project team.

Sampling locations: Index site sampling will occur at the 15 sites selected by the Steering Committee, with 3 of these designated as intensive sites, as described above for the sport fish monitoring program. Annual biosentinel sampling will occur in 2005, 2006 and 2007. Index site sampling will focus on the primary biosentinel fish species, another prevalent species, and additional small fish species as available. At approximately three intensive sites, non-primary but numerically significant small fish and macro-invertebrate species will be sampled and analyzed with more extensive replication, also in conjunction with the collection of all primary large fish species. Sampling at the intensive sites will additionally be conducted multiple times throughout each year (below).

Timing: Index site biosentinel sampling will generally be performed once each year. For the suite of sites located within the Estuary and the Sacramento and San Joaquin inflows, optimal sampling has been indicated to be in late summer or fall when the target organisms, representative young-of-year fish, have attained sufficient size to be important prey items and have integrated methylmercury bioaccumulation across the bulk of the warm season. The timing of biosentinel sampling will be coordinated with sport fish sampling and chemical sampling of aqueous and sediment parameters at overlap sites with MLML, as discussed below. Special care will be taken to minimize sampling time to reduce the chance of temporal concentration shifts affecting the interpretation of spatial data. Once a time period has been chosen for annual index sampling, it will be kept consistent throughout the three years of the project. To help place these annual measures into a potentially varying seasonal context, the intensive sites will be sampled on approximately 4 additional dates throughout the year, primarily between spring and fall. Seasonal sampling is proposed for May, July, September, November, and February.

Methods: Sample handling and analysis will follow procedures developed in prior work (Slotton et al 2002a, 2004a). Details are provided in Attachment 6. All samples will be analyzed for total mercury, and selected samples for methylmercury. The UCD analytical laboratory will participate in the QA program being established by the Bay-Delta Authority. As part of this program, splits of 5% of samples will be analyzed by an independent lab. Funds for this have been included in the budget. Sufficient tissue mass from each sample will be archived to allow for reanalysis.

Sport Fish Sampling at Index Sites and Intensive Sites. Sport fish sampling at index sites will be performed with the objective of evaluating long term trends in regional mercury contamination. Index sites will be sampled in only one year (2005) in late summer. Annual sampling of sport fish at these sites would be valuable, but is generally considered a lower priority than the other tasks included in this proposal due to the relatively long lifespans of the fish and an emphasis on the use of small fish to monitor interannual variation. It is anticipated that future monitoring of sport fish will revisit the sites established in this project with a return frequency to be established based on statistical analysis and management needs.

The primary target sport fish species at a given index site will depend on the fish assemblages present in that region. At Valley floor locations, the primary target species will include largemouth bass and white catfish. In clearer, cooler streams and rivers, primary targets will include Sacramento pikeminnow and Sacramento sucker. Different primary targets may be needed in other areas. For primary target species we will attempt to catch a minimum of 9 fish at each site, spanning a broad range of sizes, with the goal of establishing a regression between mercury and length at each location. Muscle tissue from primary target species will be analyzed individually for mercury. Secondary target species will also be collected at each index site. These secondary target species will include abundant species that are low in mercury (e.g., redear sunfish and bluegill). Secondary target species will also include other species that are of health concern due to factors such as high consumption or local concern. For secondary target species, composite samples comprised of 5 fish in a target size range will be analyzed following USEPA (2000) guidance. Other popular species that turn up in adequate numbers as bycatch will also be retained and analyzed.

At intensive sites, a focused effort will be made to collect the entire spectrum of sport fish species. This will provide information on the relative degree of contamination of different species, including high mercury species (analyzed as individuals) and medium and low mercury species (analyzed as composites). This type of sampling would be expensive and logistically infeasible to perform at all sites, but data from a few sites will allow observation of general relationships. We will seek to co-locate these intensive sites with sites being employed for process-oriented studies to create a comprehensive evaluation of mercury movement from water and sediment through the food web. These sites will be sampled in 2005, 2006, and 2007.

Gut contents of all largemouth bass and white catfish collected from index sites will be analyzed by CDFG staff. This detailed diet information will be of great value in modeling mercury accumulation in largemouth bass and white catfish in the Delta.

Sport fish samples will be collected and analyzed by MLML using protocols established for the CALFED Mercury Project, RMP, and SRWP (methods are provided in Attachment 6). Total mercury concentrations in sport fish muscle will be analyzed. The MLML and UCD analytical labs will participate in the QA program being established by the Bay-Delta Authority. Sufficient tissue mass from each sample will be archived to allow for reanalysis.

Data from sport fish monitoring at index and intensive sites will be analyzed in several ways. For sites with data from previous years, interannual variation and trends will be evaluated using the improved ANCOVA method described in Davis et al. (2003). The Mercury Strategy recommends that mercury studies in the Estuary should move from a predictive phase into a mechanistic phase. Data on mercury concentrations in the food web and diet will be used to develop a mechanistic model of mercury uptake by largemouth bass and perhaps other key indicator species. The model will combine bioenergetics and a mercury mass balance approach (Trudel et al. 2000). This modeling will help define the pathway of mercury transfer through the food web to largemouth bass, and the seasonal dynamics of uptake. Finally, correlations between sport fish mercury and other parameters will be examined using index and intensive site data, in an effort to identify factors controlling spatial variation in food web mercury.

Task 2.2. Striped Bass Monitoring

Striped bass are probably the most important indicator of mercury contamination in the region from a human health perspective. Recent sampling efforts, including the CALFED Mercury Project and the RMP, have not effectively sampled this species and yielded relatively small sample sizes. In this study, we will conduct targeted sampling of striped bass to obtain an adequate sample size. Striped bass are long-lived and can be migratory, and consequently are not suited for monitoring of shorter-term interannual variation or spatial characterization. Given their popularity with anglers, however, it is important to track mercury concentrations in striped bass on an infrequent basis (every few years) as an indicator of long term trends in the Estuary. This study will conduct focused striped bass sampling in one year only (2006), establishing a solid benchmark for future reference. This sampling will coincide with the triennial fish sampling conducted in the Bay under the RMP, which includes striped bass. These two efforts will yield the most thorough assessment of striped bass mercury in 30 years.

The timing and location of striped bass sampling will be aligned with fishing activity for this species. Multiple locations will be sampled, as previous sampling has suggested some spatial variation, possibly due to the presence of some nonmigratory subpopulations. Striped bass will be sampled using gill nets or electroshock techniques. Sampling will be in collaboration with the DFG Bay Delta Striped Bass Group. A broad range of sizes, including sub-legal (<45 cm) fish, will be collected at each location to provide suitable data for regression analysis. Striped bass will be analyzed as individuals using the same chemical methods described above for the other sport fish species (Attachment 6).

Task 3: Spatial Characterization of the Watershed

The primary objective of this Task will be to obtain directly comparable data on food web mercury throughout the watershed, identifying areas with high concentrations that pose health risks and areas with low concentrations that suggest alternative fishing locations. The study area is shown in Figure 3. Largemouth bass have been selected as the primary indicator species for this purpose because of their mercury accumulation, site fidelity, abundance, and broad distribution in rivers and reservoirs in the study area. Other species (e.g., Sacramento pikeminnow and trout) will be used in regions where largemouth bass are not present. This Task would provide a preliminary screening of regions that have not yet been covered by past sampling efforts. The emphasis will be on spatial coverage of the watershed, rather than multi-species comparisons. However, other species, depending on availability, will be retained and analyzed in order to provide guidance to the public. By defining the boundaries of the mercury problem, we will be able to steer anglers away from contaminated areas and species and toward uncontaminated areas and species. It is anticipated that more detailed studies will follow from this screening effort at many locations, focused more on the species with high rates of consumption and possibly upstream source identification.

The first step in designing this element will be to thoroughly review existing data on mercury in sport fish in the watershed (e.g., Rasmussen and Blethrow 1990, May et al. 2000). In a separate project funded by the Surface Water Ambient Monitoring Program (SWAMP), SFEI is performing a review of all historical Toxic Substances Monitoring Program data in the state. This project will begin in summer of 2004 and provide valuable background for the Program described in this proposal, and has reduced the cost of this proposal by eliminating some of the literature review work that was included in the previous submittal.

The second step will be to identify sampling sites. This will be done by the Steering Committee. Criteria to be considered in sampling site selection will include:

- input from local agencies, community groups, anglers, and others;
- amount of fishing activity;
- the presence of largemouth bass and other target species;
- location downstream or upstream of historic mining activity or contaminated sites;
- location in areas suspected to have low mercury concentrations;
- lack of coverage under past or present sampling programs; and
- location downstream of landscape features expected to affect mercury bioaccumulation.

Approximately 33 sites will be sampled each year in 2005, 2006, and 2007. The budget developed for this work assumes that ten of these sites each year will be in areas where trout are the dominant species. 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. With 100 total samples it will be possible to achieve a reasonably thorough spatial coverage of the watershed.

Much of the sampling effort will be focused on largemouth bass. A minimum of 9 largemouth spanning a wide size range will be collected from each site, following the same

approach employed at the index sites. An additional species (e.g., white catfish or Sacramento pikeminnow) will also be collected to facilitate spatial comparisons with sites where largemouth are not present. The primary target species will be analyzed individually for total mercury. The secondary target species will include low mercury species and other popular species that may be of health concern, and will be analyzed as composites. Sample collection and chemical analytical procedures will be as described above for sport fish at the index sites (Attachment 6).

Within each site, the size:mercury relationship for each primary target species will be evaluated by regression to allow among-site comparisons of standard sized fish. 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 (e.g., wetland acreage, prevalence of mines).

There have been many reports on the correlation between pH levels in lakes and methylmercury levels in fish (e.g., Kelly et al. 2003; Wiener et al 1990; Lange, et al. 1993). Lakes with lower pH have higher levels of methyl mercury in fish. In order to develop a predictive model of the effect of such factors as pH and DOC on methylmercury uptake, several ancillary measurements will be made on water samples from reservoirs that are sampled, such as pH, DOC, dissolved oxygen, temperature, salinity, sulfate, methylmercury and total mercury. In addition, we will measure methyl and total mercury in sediments. It may be possible to predict Hg bioaccumulation from these ancillary measurements if strong correlations exist.

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, informing anglers of contaminated and uncontaminated areas, identifying sources, and setting priorities for remediation. This project will provide an integrated evaluation of data from different studies, and will result in the development of a data management framework that can continue to be used in the future (discussed further under Section 4.6).

Task 4: CBDA Project Monitoring

This task will include two components. One will be the refinement of biosentinel methodologies, particularly in relation to wetlands restoration monitoring ("Protocol Development"). The second will consist of the monitoring of select representative manipulated CBDA sites, together with linkage monitoring at sites of major CBDA mercury process studies ("Site Monitoring").

Task 4.1. Protocol Development

This task will refine methodologies and address areas of uncertainty for the biosentinel approach to monitoring restoration and remediation projects. One important sub-task will include the determination of appropriate potential biosentinel organisms for use directly within a

variety of wetland tracts. At several candidate sites, a variety of sampling techniques will be tested. Once collected, candidate organisms will be assessed for potential use as biosentinels (high enough absolute mercury concentration, low enough individual variability, consistent trophic level within useful size ranges, relevance as local diet item for predaceous fish, and relatively widespread for comparability). An estimated 12 additional samplings of up to 30 individual fish and approximately 72 invertebrate composites will be associated with this subtask in each project year. A summary of the proposed sampling scheme can be found in Table 4.

In addition to the testing of potentially new biosentinel taxa (above), some of the index species characterized with composite sampling will be further investigated on an individual basis. Individual analyses will be conducted across a range of relevant small sizes. Size ranges will be determined, if present, for which Hg bioaccumulation is relatively consistent, guiding future collections. Within consistent size ranges, power analyses will be conducted to determine relative variance in composites of increasing numbers of individuals. An estimated 10 additional samplings of up to 30 individual fish will be associated with this subtask in each project year.

In a third subtask, correlations between biosentinel data and underlying measures of methylmercury production and presence will be examined. This will be done through close coordination with MLML. In separately funded work, MLML will investigate aqueous on/off tract methylmercury loading, sediment methyl and total mercury, and a variety of ancillary parameters that have been found to be relevant to net methylmercury production in wetlands, including organic percentage, sulfur chemistry, and suspended solids (e.g., Brumbaugh et al. 2001). Biosentinel bioaccumulation will be compared to these underlying parameters at approximately 6 sites across a range of conditions, supporting the modeling of potential linkages.

The methods we develop and refine in a range of wetland habitats will provide a basis for future monitoring of many or all of the restoration projects as they commence.

Task 4.2. CBDA Site Monitoring

In this task, monitoring with biosentinels will be performed at a select group of CBDA restoration, remediation, and process study sites. As described above for Task 4a, methods will center on UC Davis biosentinel monitoring, supplemented at a subset of sites with aqueous loading and sediment work in collaboration with MLML, and sport fish monitoring. The biosentinel monitoring is designed to track potential changes in net methylmercury exposure at these sites and provide a linkage to the wider mercury monitoring program. While it will be beyond the scope of this program to intensively monitor every restoration, remediation, or process study site, the program will provide annual biosentinel monitoring at approximately 12 sites associated with the most important and representative projects as they commence and before. We realize that many of the more significant planned restoration and remediation projects may not begin construction for a number of years. However, it will be important to obtain pre-construction baseline data from the general project area. Annual biosentinel monitoring will provide a relatively cost effective performance measure that can be placed into the wider context of the index monitoring network. A subset of the sites will be chosen in conjunction with the additional CBDA-funded MLML project. As discussed above in relation to

Protocol Development, several of the sites will include MLML monitoring of on/off tract aqueous loading, sediment methyl and total mercury, and key ancillary parameters linked to mercury methylation. CBDA site monitoring locations, like the index sites, will be chosen with the input of the Steering Committee. Candidates for restoration site monitoring include the Napa Marsh complex, Dutch Slough, and the North Delta Wetlands. Candidates for remediation site monitoring include Cache and Marsh Creeks. Candidates for overlap with process studies include the Cosumnes River and Franks Tract. The proposed sampling scheme is presented in Table 4.

Task 5: Data Interpretation and Reporting

Subtasks under this SFEI task include:

1. literature review in support of sampling design and data interpretation, data compilation, statistical analysis, and interpretation;
2. modeling mercury uptake by largemouth bass;
3. analysis of association between spatial patterns in the watershed with landscape attributes; and
4. reporting of results in publications (annual reports, newsletters, fact sheets, journal articles) and presentations.

These tasks are described in other sections of this proposal and are not repeated here.

Task 6: Stakeholder Involvement

Active participation from local stakeholders is an essential part of the program. Local involvement will ensure that monitoring and risk communication activities are responsive to local needs and concerns, coordinated with ongoing programs, and build local capacity to reduce exposure to mercury in affected populations. Stakeholder involvement activities will build on past and ongoing efforts in the Bay-Delta watershed to ensure input from and participation of affected populations and the local organizations that serve them. Activities will include:

Task 6.1. Evaluate Fishing Activities

An evaluation of fishing activities will be conducted to provide guidance to the SC and ensure that the selection of monitoring sites and species reflect actual fishing practices and local input. This evaluation will be coordinated with ongoing activities by EHIB to collect and analyze background data on fishing in the Delta watershed that supports the planning of a fish consumption survey of anglers. These ongoing activities, which are supported by CBDA and the Central Valley Regional Water Quality Control Board, are conducted with input from an interagency group - the Fish Consumption Studies Group (FCSG). Fishing evaluation activities under this proposal will build on the ongoing activities and will be conducted in collaboration with FCSG. Evaluation of fishing activities in the watershed will include:

- Review of existing creel data, and fish consumption, boating, and recreation survey data (e.g., CDPR 1997, CDFG 2001, Shilling 2004) to identify important fishing locations, species, and populations in the watershed;

- Implementation of a written survey about important fishing locations, species, populations, and specific local concerns regarding fish contamination problems. The survey will be conducted with key fishing contacts such as local agency staff, anglers, and others knowledgeable about local fishing activities;
- Site visits to important fishing locations and interviews of key fishing contacts to gather more in-depth information about fishing locations, species, populations, and local concerns.

The evaluation of fishing activities will be used to develop specific recommendations on monitoring sites and species for the SC. These recommendations will be developed for each year of monitoring, focusing on the selection of the index and spatial characterization sites. Information gathered under this subtask, along with input from the SC, will also be used to guide selection of the three priority counties discussed below.

Task 6.2. Conduct Needs Assessments

In-depth needs assessments will be conducted with local stakeholders in three counties in the watershed. These counties will be selected with SC input based on information gathered under Task 6.1, considering factors such as (1) the presence of a fish advisory; (2) environmental justice concerns; and (3) areas where the need to reduce exposure to mercury is the greatest. These needs assessments will be similar to the needs assessments already conducted by EHIB in five counties in the watershed (Sacramento, San Joaquin, Yolo, Placer, and Lake), and underway in Contra Costa and Solano Counties (Attachment 1). Stakeholders may include local governmental agency staff, Native American tribal agency staff and members, health care providers, community-based organizations (CBOs), and environmental groups, among others to be identified. Key informant interviews, focus groups, and surveys will be conducted to obtain the following types of information:

1. local awareness, concerns, and information needs regarding fish contamination and consumption guidance;
2. important fishing locations, fishing populations, and species consumed;
3. appropriate risk communication methods;
4. training needs of local governmental agencies, CBOs, and other stakeholder groups; and
5. opportunities for collaboration with local programs serving affected populations.

Needs assessment findings will guide subsequent risk communication activities in the watershed.

Task 6.3. Convene Stakeholder Advisory Groups

The formation of a Stakeholder Advisory Group is essential for ensuring participation from local stakeholders and engaging them in activities aimed at increasing public awareness about local fish contamination problems. A Delta Stakeholder Advisory Group (Delta SAG) was formed in November 2003, and includes representatives of agencies and organizations serving affected populations in Sacramento, San Joaquin, and Yolo Counties. With support from this proposal, the Delta SAG will continue and its membership may be expanded to include stakeholders from other counties in the watershed or additional SAGs may be formed, as appropriate. The SAGs will enable local stakeholders to remain informed and provide input to the program, particularly in the area of risk communication with affected populations.

Specifically, SAG members will participate in the development, translation, dissemination, and evaluation of outreach, education, and training materials and activities described in Task 7. In addition, SAG representatives will participate on the SC.

Task 7: Risk Communication

Risk communication with affected populations is the most effective way to reduce mercury exposure in the short-term and, therefore, will be a critical component of the program. Risk communication activities will build on past and ongoing efforts in the Bay-Delta watershed to inform affected populations about the health risks of exposure to mercury in fish, and ways to reduce exposures.

Task 7.1. Communicate with Community Leaders

Community leaders (e.g., local elected officials, civic leaders, clergy) in the counties encompassing the priority areas of the watershed will be informed about the program via a letter and companion document describing the program and providing contact names for additional information. This communication will ensure that community leaders are aware of the program, its purpose, and activities in case they are contacted by their constituents or the media, and presents an opportunity for their input to the program.

Task 7.2. Enhance Existing Risk Communication Strategy

In July 2003, EHIB received a grant from CBDA to develop a risk communication strategy based on the findings of the needs assessments conducted in five counties in the watershed during 2002-2003. The strategy responds to the recommendations generated by the needs assessments. These include:

1. develop and disseminate outreach and education messages and materials in collaboration with local government agencies, tribes, and CBOs;
2. use visual images (e.g., pictures, posters, calendars, videos) and mass media (e.g., television and radio) to effectively communicate messages to target populations;
3. collaborate with health care providers (i.e., family practice physicians, obstetricians, gynecologists, pediatricians, physicians assistants, and nurse practitioners) to inform target populations, especially women of childbearing age; and
4. evaluate outreach and education activities on an ongoing basis to ensure the effectiveness and appropriateness of messages, materials, and communication methods.

Currently, EHIB is implementing elements of the strategy, specifically community outreach and education, in Sacramento, San Joaquin, and Yolo Counties in collaboration with Delta SAG members. EHIB will modify the existing risk communication strategy, as necessary, to address the specific objectives of this program and to respond to the findings of needs assessments that will be conducted in three additional counties. The revised strategy will identify risk communication activities that may be implemented in all counties targeted by the program as well as activities that may be more appropriate for specific counties, communities, or populations.

Task 7.3. Develop Messages and Materials

Risk communication messages and materials will be developed in partnership with CBOs and local governmental agencies. This collaboration will be supported by 4-5 mini-grants that will be awarded via a competitive bidding process to CBOs and local agencies serving affected populations in the watershed. The provision of mini-grants will enable CBOs and local agencies to produce their own materials that are culturally and linguistically appropriate. The specific activities and materials will be guided by the needs assessment findings and determined by the SAG members. Methods and materials may include: ethnic and other media, materials that emphasize visual images (e.g., posters, calendars), a multilingual video, multilingual fact sheets; and postings on the EHIB and other web sites. The materials will focus on presenting a balanced message and include issues related to fish contamination and health risks associated with exposure to mercury in fish, as well as ways to reduce exposure, the health benefits of fish, and safe (low mercury) species and areas. Some materials will focus specifically on informing affected communities about the fish monitoring activities. For example, EHIB may develop a multilingual newsletter or fact sheet, which would supplement the Annual Report for the project to specifically inform affected communities about the monitoring activities. SAG member agencies/organizations among others will assist in disseminating the materials to their constituents.

Task 7.4. Conduct Trainings

Trainings will be conducted for SAG member agencies and organizations including county agencies, Native American tribal organizations, CBOs, and health care providers. The aim of the trainings will be to build capacity at the local level to address fish contamination-related issues, thereby fomenting a sustainable, local response to the problem. A major focus of the trainings will be on risk communication, emphasizing the development and dissemination of accurate and appropriate information to the public, especially highly exposed and sensitive populations. EHIB will use a train-the-trainer approach with county agency programs and CBOs, and will coordinate with Physicians for Social Responsibility or similar organizations to deliver a series of CME seminars to appropriate health care providers. Training modules and materials will be developed in English and other priority languages, and will emphasize interactive learning approaches. Each training will be evaluated using a pretest/posttest tool.

Task 7.5. Convene Forum

A forum will be convened in the first half of Year 3 involving members of the SC and SAGS, state, local, and tribal agencies, and CBOs serving affected populations in the Bay-Delta watershed, among others. The forum objectives include: (1) to share information on monitoring and risk communication activities completed or underway in the watershed; (2) to identify lessons learned; (3) to showcase effective risk communication methods and materials; and (4) to identify next steps. A forum proceedings will be produced.

Task 7.6. Evaluate Stakeholder Involvement and Risk Communication Activities

The usefulness and effectiveness of stakeholder involvement, and outreach, education, and training activities and materials will be evaluated on an ongoing basis to better ensure achievement of the program's objectives. An evaluation plan will be developed that includes appropriate process and impact measures to monitor the program's stakeholder involvement and risk communication activities, and make timely adjustments, as necessary, to ensure their effectiveness. Additional activities may be warranted based on evaluation findings. Peer review of this task will provide an additional mechanism for evaluation.

4. Feasibility SFEI and MLML have collaborated on sport fish sampling projects for many years, including the Sacramento River Watershed Program, the Delta Fish Study, the CALFED Mercury Project, and a CBDA-funded study evaluating contaminant effects on splittail. Based on experience from these projects it is considered feasible to conduct this sampling. If necessary, DFG staff from the Water Pollution Control Lab (WPCL), which performed 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. UC Davis has conducted sampling of small fish and invertebrates in the region for many years, including extensive sampling in the ERP project "Effects of Wetland Restoration on the Production of Methylmercury in the San Francisco Bay-Delta System." SFEI, MLML, DFG, and UC Davis all collaborated successfully in the recent CALFED Mercury Project. An earlier review concern was the reliance on an outside contract laboratory for certain analyses. UC Davis has now established a reliable methylmercury capability for biotic samples. In addition, by working together with MLML, all mercury analyses will be conducted "in-house". EHIB staff have extensive experience coordinating local involvement and conducting risk communication activities on a variety of environmental health issues including fish contamination. The outreach, education, and training activities proposed in this project are modeled after successful programs conducted by EHIB staff in this region and other areas of the state.

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 design, implementation, and interpretation. The model established in the CALFED Mercury Project will be followed.

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

- Complete subcontracts with MLML, DFG, UC Davis, and DHS/IAI
- Submit quarterly fiscal and programmatic reports on time
- Develop peer-reviewed annual sampling plans
- Obtain target numbers and/or statistical confidence 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

- Present findings at annual review meetings, other symposia, and at meetings of stakeholder groups
- Create and convene quarterly SAG and SC meetings
- Conduct needs assessments and trainings
- Develop, translate, and disseminate multilingual outreach and educational messages and materials
- Develop and implement multilingual training modules and materials
- Coordinate and communicate with state, local, and tribal agencies, CBOs, environmental groups, the media, and the public
- Evaluate the effectiveness of stakeholder involvement and risk communication activities
- Produce forum proceedings and peer-reviewed final report
- Present findings and raw data on the web
- Publish results in peer-reviewed journal

6. Data Handling and Storage Several monitoring and assessment programs at a statewide as well as regional scale are beginning to identify mechanisms for integrating and exchanging data from different sources to address management and assessment questions common to all. Data and information management approaches, including formatting, storing, updating, and distribution, are increasingly being reevaluated among several of these programs (e.g. Surface Water Ambient Monitoring Program, Resource Assessment Program, San Francisco Estuary Regional Monitoring Program, Regional Wetlands Monitoring Program). The ultimate goal is to establish consistent and thus more efficient storage, access and exchange of environmental data statewide.

Tissue contamination, especially by mercury, stands as a primary factor influencing the effectiveness and risks associated with CBDA-sponsored ecosystem restoration actions. Associated water contamination data establishes part of the context for understanding processes controlling tissue contamination. The proposed task will take advantage of the present opportunity to further the convergence of state environmental data storage and access by working collaboratively with SWAMP and BDAT participants to adopt consistent storage for tissue and water contamination data as a step towards full-scale implementation of a California Environmental Data Exchange Network (CEDEN). A standard tissue data format will thus be shared between CBDA, SWRCB, DWR (BDAT) and SFEI, strengthening the format as a standard for future data collection efforts in the state and utilizing the efforts currently undertaken by USEPA to summarize fish contamination data for 303(d) listing evaluation.

The San Francisco Estuary Institute is the data steward of one of the largest tissue contamination databases in the state and is poised to become the Bay Area “node” within the planned databases network. As part of this work effort, we propose the following subtasks.

1. Working with BDAT staff, adopt the draft tissue contaminant database schema (BDAT v2.2 family) developed by BDAT staff, in collaboration with SWAMP and other tissue monitoring participants, into SFEI's database management system, thus further promoting it as the California tissue data storage standard. Implement the "Export Module" or

equivalent included with the database. As part of this task, SFEI will review and provide comments on the schema to Karl.

2. Data entry and/or conversion to bring the following datasets into the tissue database:
   - The data generated under the other tasks of this proposal;
   - All other SFEI tissue data (1993-present); and
   - Selected historical tissue data.
3. Development and maintenance of an intuitive, easy to use, public web-based interface for assessing tissue data holdings and downloading selected datasets from those entered in subtask 2.
4. Working with BDAT staff, adopt a subset of the database schema (BDAT v2.2 family) into SFEI's database management system, and perform conversions to house the RMP's water quality data.

7. Expected Products/Outcomes

- Peer-reviewed interpretive annual project reports
- Presentations at annual review meetings, symposia (e.g., CBDA Science Conference, NorCal SETAC, SETAC), and at meetings of stakeholder advisory groups and committees (e.g., the Sacramento River Watershed Program, the CBDA Justice Subcommittee, the Fish Consumption Planning Group, regional meetings of the California Conference of Directors of Environmental Health and the California Conference of Local Health Officers)
- Data, maps, and reports accessible through the SFEI website
- Peer-reviewed final report
- Peer-reviewed journal publication
- An organized network of stakeholders
- Public outreach and educational materials (newsletters, fact sheets)
- Training modules and workshops for local and tribal agencies, community-based organizations, and others
- Continuing medical education seminars for health care providers

8. Work Schedule The work schedule for the project is shown in Table 6xx. This schedule assumes that funds would be available and work could begin in November 2004. Tasks 2, 3, 4, 6, and 7 and subtasks identified therein, are separable. If particular tasks were deleted, Tasks 1 and 5 would be reduced proportionately.

B. Applicability to CBDA 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 CBDA 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.

As described in the Mercury Strategy (Wiener et al. 2003), success in achieving most of the goals of the Ecosystem Restoration Program (ERP) will depend in part on the behavior and mitigation of mercury in the ecosystem, which, in turn, will depend on effective monitoring of mercury in the food web.

- 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." Environmental justice is one of the CBDA Program's broad commitments, and a specific priority of the ERP. Mercury in fish raises concerns about environmental justice, as certain groups can be more heavily exposed via high rates of fish consumption (SFEI 2001), a situation considered probable in the Delta (Wiener et al. 2003). The stakeholder involvement and risk communication activities included in this project would identify, involve, and educate these adversely impacted groups.

This project would meet several of the stated priorities of the CBDA 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 invertebrate biosentinels are valuable indicators of fine-scale spatial and temporal trends, facilitating the statistical differentiation of both natural and human-based variation in methylmercury exposure and bioaccumulation.
- *Advance process understanding.* The information obtained in this project would advance understanding of the processes that drive mercury accumulation in fish and how they vary in time and space. Linkage of this study with process-oriented studies of the mercury cycle 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 watershed with coordinated QA, interpretation, and peer review will create an integrated program of mercury study.
- *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 watershed.
- *Coordinate and extend existing monitoring.* The proposed project would be coordinated with other existing monitoring activities, and would be coordinated with other studies of mercury fate and long term trends in the watershed.
- *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 CBDA 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."
- **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."

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 and remediation monitoring elements), 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 studies, monitoring efforts, and restoration and remediation projects (Table 2 and Attachment 3).

3. Request for Next Phase Funding This project would be a continuation of the food web 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 the Production of Methylmercury in the San Francisco Bay-Delta System.* 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 6 and 7.

4. Previous recipients of CBDA 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 final year. SFEI and MLML are performing field sampling and analytical chemistry. *ERP-99-B06 Assessment of the Ecological and Human Health Impacts of Mercury in the Bay-Delta Watershed* – SFEI and MLML performed sport fish monitoring. The project and a final report are completed (Attachment 6).

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 article: Davis, J.A., J.N. Collins, D. Yee, S. Schwarzbach, and S.N. Luoma. 2003. Issues in San Francisco Estuary tidal wetlands restoration:

Potential for increased mercury accumulation in the Estuary food web. San Francisco Estuary and Watershed Science 1, Article 4.

MLML: *ERP-99-B06 Assessment of the Ecological and Human Health Impacts of Mercury in the Bay-Delta Watershed* – Final report completed (Attachment 6). *Transport, Cycling and Fate of Mercury and Monomethyl Mercury in the San Francisco Delta and Tributaries* – The project is just beginning.

UC Davis: *ERP-97-C05 Effects of Wetlands Restoration on the Production of Methylmercury in the San Francisco Bay-Delta System* – Completed (Attachment 7). *ERP-99-B06 Assessment of the Ecological and Human Health Impacts of Mercury in the Bay-Delta Watershed* – Final report completed. *Upper Yuba River Studies Program (spatial mercury bioaccumulation assessment portion)* – Work is in progress.

EHIB: *Research, Outreach, and Education on Fish Consumption in the Sacramento-San Joaquin Delta and its Tributaries* (Contract No. 4600002762). EHIB will create and convene advisory groups, conduct needs assessment activities, develop an outreach, education, and training strategy, develop an evaluation plan, and gather data and define goals and objectives for planning of a fish consumption study. *Research, Outreach, and Education on Fish Contamination in the Sacramento-San Joaquin Delta Watershed, Phase 2* (funding anticipated for 2004) – This project will continue ongoing stakeholder involvement, needs assessments, outreach, education, and training, and fish consumption studies on fish contamination in the Delta.

5. System-Wide Ecosystem Benefits Mercury is a system-wide problem in the watershed, and the ecosystem will benefit from system-wide regional monitoring of mercury in fish as a key component for the Strategy for avoiding increasing, and eventually decreasing, mercury exposure to humans and wildlife. The synergism of this fish monitoring program with other monitoring, research, restoration, and remediation projects will lead to the most effective possible approach for minimizing mercury accumulation in aquatic food webs.

C. Qualifications

Dr. Jay Davis of SFEI will be the principal investigator for the project (Figure 6), and will be assisted by SFEI staff in managing the project, and interpreting and reporting on the findings. Mark Stephenson will direct MLML efforts. Gary Ichikawa (bio in Attachment 8) will direct the sport fish sample collection and processing. Dr. Darell Slotton will direct all aspects of the biosentinel research and monitoring. Dr. Maura Mack and Alyce Ujihara (Attachment 8) will coordinate activities directed at local involvement and public outreach and education. Dr. Robert Smith and Dr. Don Stevens (Attachment 8) will provide guidance on sampling design and power analysis.

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

Dr. Davis has performed research on contaminant issues in the Bay-Delta for 17 years. The accumulation and effects of persistent, bioaccumulative toxicants has been an area of

particular emphasis. Dr. Davis is manager of the RMP, a $3 million/year program that monitors toxic chemicals in San Francisco Bay, and is an excellent model of an adaptive monitoring program. Dr. Davis has been principal investigator (PI) 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. 2) The Regional Monitoring Program (RMP) sport fish monitoring program for San Francisco Bay. Dr. Davis has been PI since this monitoring began in 1997. 3) The fish contamination monitoring element of the Sacramento River Watershed Program. Dr. Davis has been PI 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.

Mark Stephenson, San Jose State University Foundation

Mark Stephenson was the principal investigator for the first CALFED Mercury Project. This was 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 is the current principal investigator for the recently funded project Transport, Cycling and Fate of Mercury and Monomethyl Mercury in the San Francisco Delta and Tributaries An Integrated Mass Balance Assessment Approach with Gary Gill, Chris Foe, and Kenneth Coale as co-principal investigators. 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.

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 over 15 years. He has led investigations of copper, zinc, and cadmium contamination at Iron Mountain Mine, Keswick Reservoir, and Camanche Reservoir, where sediment resuspension and metals transport, solubility, and bioavailability were studied. Since 1985, he has run a mercury monitoring and research program at Davis Creek Reservoir and a mercury analytical laboratory at UC Davis. Dr. Slotton led a research program throughout the gold mining region of the Sierra Nevada, focusing on benthic invertebrates and fish as sentinels of relative bioavailable mercury exposure. He conducted a multi-year study of mercury mass loading, bioaccumulation, and remedial options at the Mt. Diablo Mercury Mine and Marsh Creek watershed. Darell has led numerous mercury investigations throughout the Cache and Putah Creek watersheds and has been a long-time participant in the Clear Lake Superfund Mercury Study. Other projects include ongoing

investigations of mercury issues in the Truckee River and Pyramid Lake, Nevada, the Lake Titicaca watershed of Peru, and the Ayeyarwady River system of Myanmar. Since 1998, Dr. Slotton's primary focus has been directing several regional projects funded by the CBDA. One was a Delta study of mercury bioaccumulation, methylation, and the implications for wetlands restoration projects. Another focused on the Cache Creek watershed, determining the trophic relationships in localized mercury bioaccumulation, and the relationship to aqueous mercury chemistry. Dr. Slotton's most recent grant award investigates the mercury bioaccumulation implications of a potential large dam removal project on the Yuba River.

Dr. Maura Mack, California Department of Health Services /Impact Assessment, Inc.

Dr. Mack is chief of the Community Participation and Education Section in the EHIB of the California Department of Health Services. She has 10 years of experience conducting stakeholder involvement activities and developing and implementing environmental health outreach, education, and training in diverse communities. Since 2001, Dr. Mack has supervised EHIB's fish contamination-related stakeholder involvement, outreach, and education projects in the San Francisco Bay and the Los Angeles Palos Verdes Shelf area. More recently, she guided the planning and implementation of a needs assessment related to mercury contamination of fish in five counties located in the Sacramento-San Joaquin Delta Region. Currently, she supervises outreach, education, and stakeholder involvement activities of the Delta Watershed Fish Program. Dr. Mack is also overseeing the development California Water Quality and Fish Contamination Project, a statewide strategic planning initiative to encourage collaboration among the many agencies and organization involved in fish contamination and related issues. Dr. Mack will direct EHIB's future fish contamination-related stakeholder involvement, outreach, education, and training activities in the Delta Region.

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 and 7 (Stakeholder Involvement and Risk Communication) of this grant, Impact Assessment, Inc. (IAI) will serve as the fiscal agent responsible for grant management including financial management, monitoring and reporting, personnel and benefits administration, consultant agreements and subcontracts, and purchasing and lease agreements. IAI has served as the certified "bona fide" fiscal agent to the EHIB of the California Department of Health Services since 1986. IAI is a state and federally recognized small business enterprise, and has assisted CDHS on the conduct of over 300 individual studies over the last eighteen years.

2. Cost-Sharing EHIB will contribute $93,029 of staff support over three years.

E. Local Involvement This project will include an extensive effort to involve the public and local agencies, as described in the Approach section, Task 6.

F. Compliance with Standard Terms and Conditions SFEI will be the primary contracting entity with CBDA. The standard terms and conditions are acceptable to SFEI.

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Table 1. Proposed membership of Steering Committee. Other members could be added based on guidance from the Committee.

Representatives from:

- Bay-Delta Authority, including the:
  - contract manager
  - mercury coordinator
  - QA program lead
  - restoration project leads
- Central Valley Regional Water Quality Control Board
- San Francisco Bay Regional Water Quality Control Board
- State Water Resources Control Board (SWAMP)
- OEHHA
- DHS
- DFG
- SRWP
- RMP
- UC Davis
- USGS
- Deltakeeper
- Environmental advocacy organizations
- Angler organizations
- Stakeholder Advisory Groups: representing county health agencies, community-based organizations, and the public
- Restoration project representatives

Table 2. Other efforts that the Pilot Program will coordinate with.

Project	**Principal Investigator/Contact**
Monitoring and Research Programs	
Evaluation of Mercury Transformations and Trophic Transfer in the San Francisco Bay/Delta	Mark Marvin-DiPasquale and Robin Stewart, USGS
Transport, Cycling and Fate of Mercury and Monomethyl Mercury in the San Francisco Delta and Tributaries An Integrated Mass Balance Assessment Approach	Mark Stephenson, MLML
Mercury in San Francisco Bay-Delta Birds: Trophic Pathways, Bioaccumulation and Ecotoxicological Risk to Avian Reproduction	Tom Suchanek, USFWS
Mercury and Methylmercury Processes in North San Francisco Bay Tidal Wetland Ecosystems	Don Yee, SFEI
San Francisco Bay Regional Monitoring Program	Jay Davis, SFEI
Sacramento River Watershed Program	Jay Davis, SFEI
Surface Water Ambient Monitoring Program	Val Connor, SWRCB
Delta Resident Shoreline Fish Monitoring Program	Chuck Armor, DFG
Integrated Regional Wetlands Monitoring Pilot Project	Stuart Siegel
Delta Watershed Fish Program, Fish Consumption Studies Group	Alyce Ujihara, DHS
Stakeholder Involvement/Risk Communication	
Delta Watershed Fish Program, Delta Stakeholder Advisory Group and Technical Advisory Group	Sun Lee, DHS
San Francisco Bay Fish Outreach and Education Task Force	Ian Walker, DHS
California Water Quality and Fish Contamination Project	Maura Mack, DHS
CALFED restoration projects	
Napa River	Dan Ray, CBDA
North Delta Improvement Project	Lauren Hastings, CBDA
Dutch Slough	Lauren Hastings, CBDA
Yolo Bypass	Lauren Hastings, CBDA
Possible remediation projects	
Sulphur Creek complex	
Abbott and Turkey Run Mine complex	
Mt Diablo Mercury Mine	
Programmatic initiatives	
Mercury Coordinator	
QA Program	Dave Crane, CDFG
Data management efforts	Karl Jacobs, DWR

Table 3. Preliminary design of sport fish sampling. A) Numbers of each type of site to be sampled in each year of the project. B) Species and compositing scheme for each type of sampling site.

A)

Year	Index Sites	Intensive Sites	Striped Bass	Restoration Sites	Spatial Characterization Sites
2005	12	3	0	3	33
2006	0	3	100 fish	3	33
2007	0	3	0	3	33

B)

Type of Site	Primary Targets	Secondary Targets	Bycatch
Index	Largemouth and one other species (individuals)	2 low mercury species (composites), 2 other species of health concern	Kept when numbers are adequate
Intensive	Largemouth and two other species (individuals)	5 species (composites)	Kept when numbers are adequate
Striped bass	100 fish (individuals)	-	-
Restoration	Largemouth (if possible) and one other species (individuals)	-	Kept when numbers are adequate
Spatial Characterization	Largemouth and one other species (individuals)	2 low mercury species (composites), 2 other species of health concern	Kept when numbers are adequate

Table 4. Preliminary design of biosentinel sampling. A) Numbers of each type of site to be sampled in each year of the project. B) Species and compositing scheme for each type of sampling site.

A)

Year	Index Sites	Intensive Sites	Protocol Development Sites	Restoration , Remediation, and Process Study Sites
2005	12	3	3	12
2006	12	3	3	12
2007	12	3	3	12

B)

		Indiv. Samples (to 30/sample)	Multi-Ind. Composites
Index Sampling			
Basic Sampling	15 sites x 1 taxon x 30 individuals	450	
	12 sites x 1 taxon x 5 comps		60
	12 sites x 4 taxa x 1 comp		48
Intensive sites, other sm fish	3 sites x 4 taxa x 30 ind.	360	
Intensive sites, +4 dates, main taxon	4 dates x 3 sites x 1 taxon x 30 ind.	360	
Intensive sites, +4 dates, comps	4 dates x 3 sites x 5 taxa x 1-5 comps		108
Protocol Development			
Testing new indicators (fish)	3 sites x 2 dates x 2 taxa x 30 ind.	360	
Testing new indicators (inverts)	3 sites x 2 dates x 2-3 taxa x 4 comps		72
Power analysis of alternate species	10 additional samplings x 30 ind.	300	
CBDA Site Monitoring	12 sites x 1 taxon x 30 individuals	360	
	12 sites x 5 taxa x 1-5 comps		108
		2190	**396**
	Projected maximum total analytical samples/yr:		**2586**

Table 5. List of candidate index sites.

1. Sacramento River at River Mile 44
2. San Joaquin River at Vernalis
3. Frank's Tract
4. Prospect Slough
5. Cosumnes River
6. Napa River
7. Feather River near Nicolaus
8. American River near Discovery Park
9. Yuba River
10. Colusa
11. Stanislaus River
12. Tuolumne River
13. Merced River
14. Mud Slough
15. Dutch Slough

Table 6. Project timeline.

		2004				2005				2006				2007			
		Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
TASK 1	**PROJECT MANAGEMENT**																
1.1	Contract and Financial Management				X	X	X	X	X	X	X	X	X	X	X	X	
1.2	Coordination				X	X	X	X	X	X	X	X	X	X	X	X	
1.3	Program Design				X	X	X	X	X	X	X	X	X	X	X	X	
1.4	QA Oversight				X	X	X	X	X	X	X	X	X	X	X	X	
1.5	Data Mgmt/GIS/Web				X	X	X	X	X	X	X	X	X	X	X	X	
TASK 2	**TEMPORAL TREND MONITORING**																
2.1	Index and Intensive Sites				X	X	X	X	X	X	X	X	X	X	X	X	
2.2	Striped Bass											X					
TASK 3	**SPATIAL CHARACTERIZATION OF WATERSHED**																
3.1	Sport fish collection and analysis						X	X	X			X	X	X		X	X
TASK 4	**PROJECT MONITORING**																
4.1	Protocol Development				X	X	X	X	X	X	X	X	X	X	X	X	
4.2	Monitoring of selected sites				X	X	X	X	X	X	X	X	X	X	X	X	
TASK 5	**DATA INTERPRETATION AND REPORTING**																
5.1	Literature Review, Data Compilation, and Interpretation				X	X	X	X	X	X	X	X	X	X	X	X	
5.2	Modeling mercury uptake by key indicator species				X	X	X	X	X	X	X	X	X	X	X	X	
5.3	Analysis of landscape attributes associated with mercury accumulation				X	X	X	X	X	X	X	X	X	X	X	X	
5.4	Annual report and publications								X	X			X	X		X	
5.5	Presentations at annual meeting, symposia				X	X	X	X	X	X	X	X	X	X	X	X	
TASK 6	**STAKEHOLDER INVOLVEMENT…**																
6.1	Evaluate fishing activities				X	X	X	X	X	X	X	X	X	X	X	X	
6.2	Conduct needs assessments				X	X	X	X									
6.3	Convene stakeholder advisory groups				X	X	X	X	X	X	X	X	X	X	X	X	
TASK 7	**RISK COMMUNICATION**																
7.1	Communicate with community leaders				X				X				X				
7.2	Enhance existing risk communication strategy				X	X	X	X									
7.3	Develop messages and materials				X	X	X	X	X	X	X	X	X	X	X	X	
7.4	Conduct trainings				X	X	X	X	X	X	X	X	X	X	X	X	
7.5	Convene forum													X			
7.6	Evaluate stakeholder involvement				X	X	X	X	X	X	X	X	X	X	X	X	

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

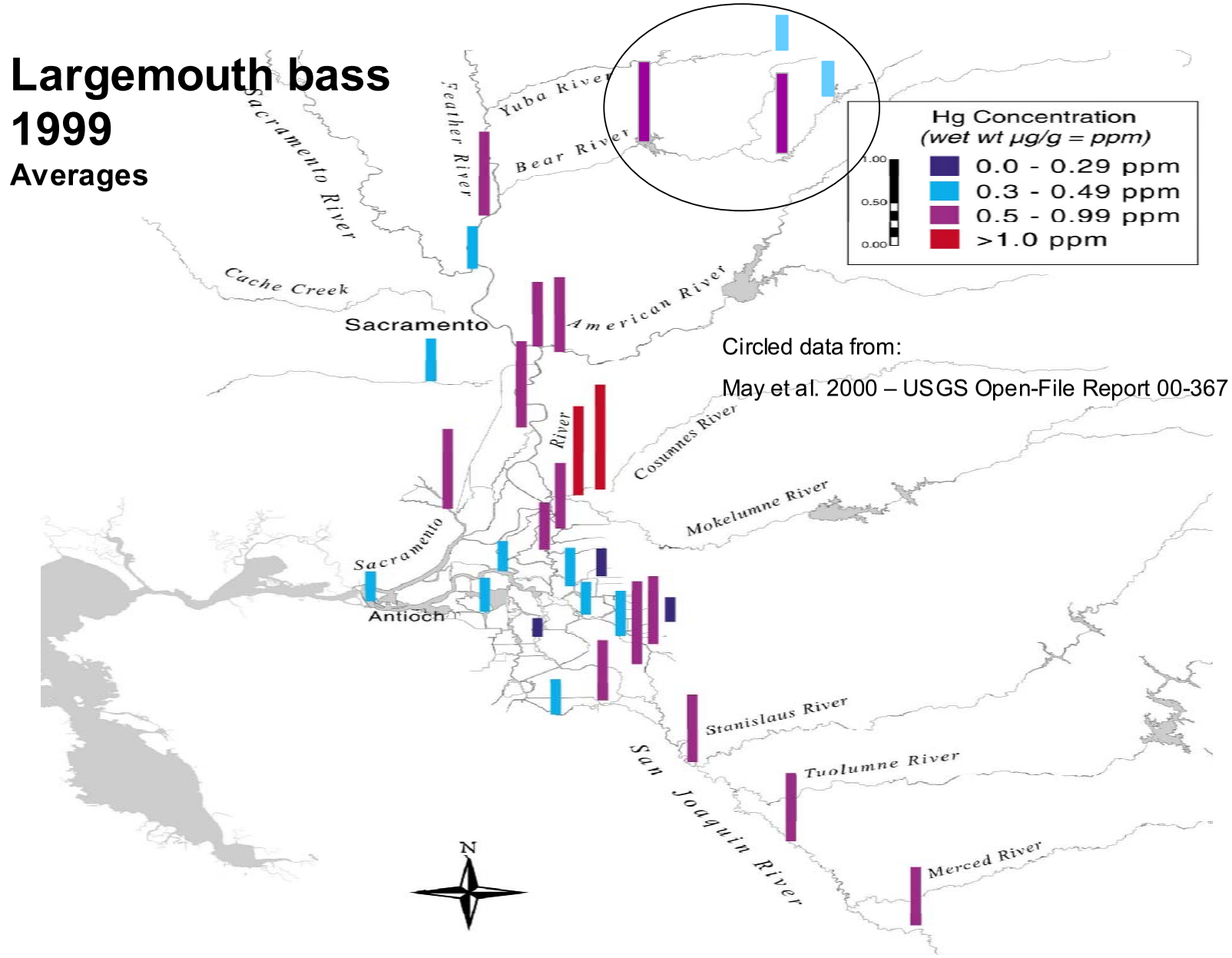


Figure 2. Average mercury concentrations in largemouth bass at CALFED Mercury Project sites in 2000.

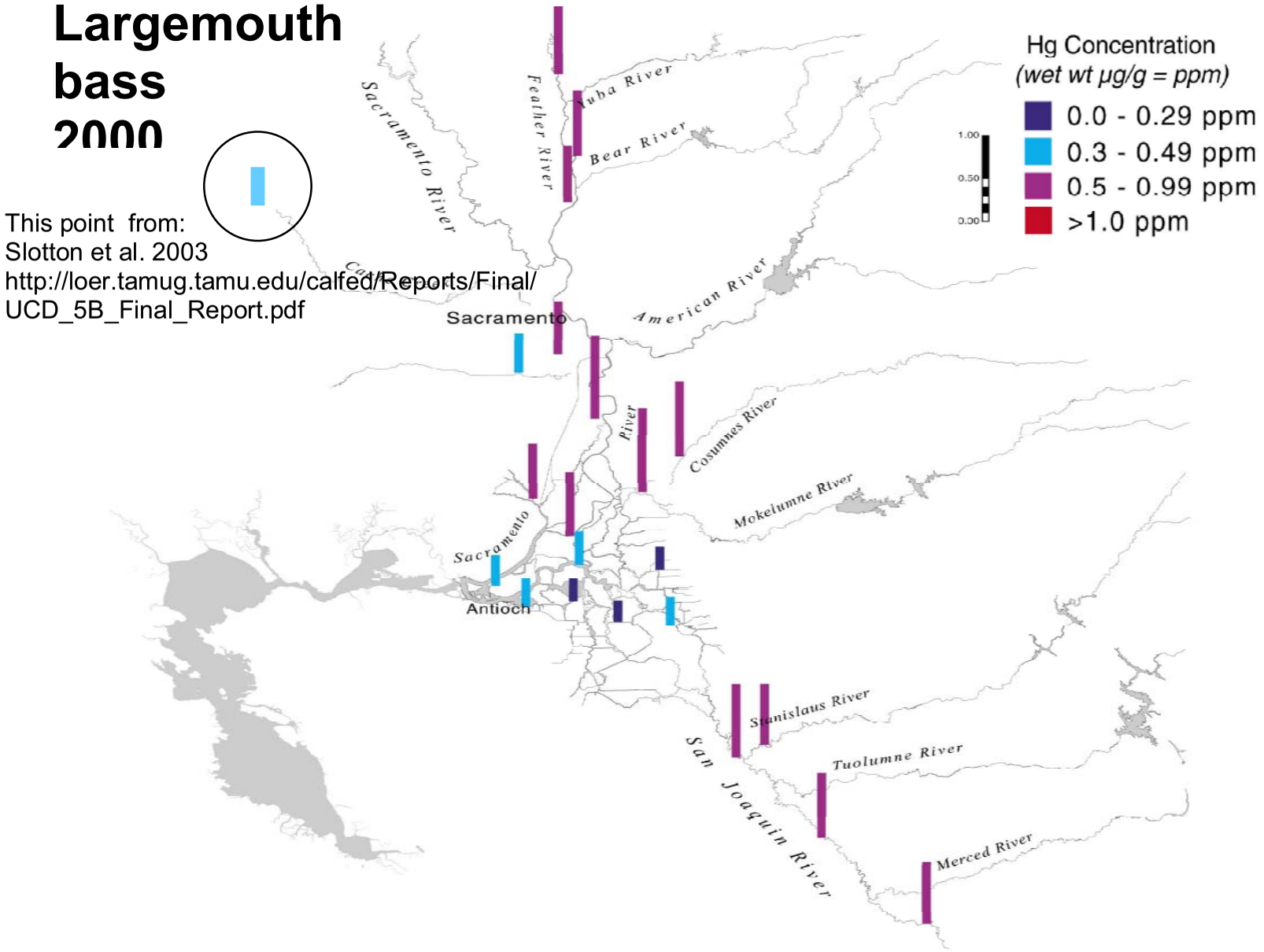
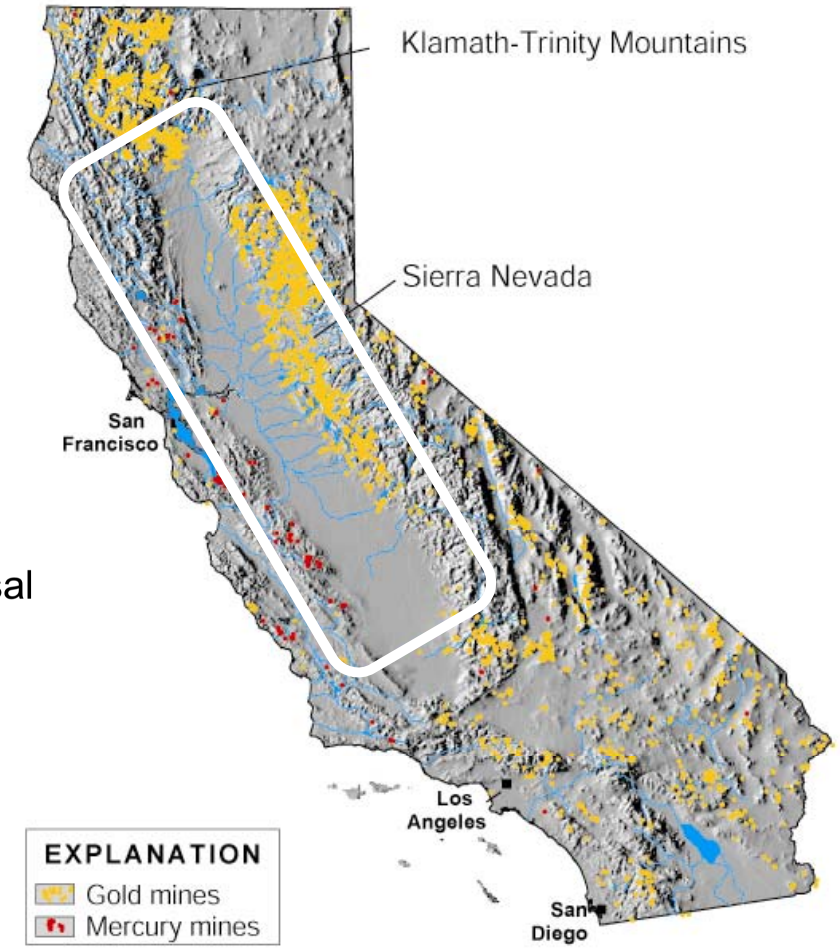


Figure 3. Distribution of historic gold and mercury mines in the watershed. Map from Alpers and Hunerlach (2000) – USGS Fact Sheet FS-061-00



White rectangle indicates proposal study area

Figure 4. Advisories issued by the California Office of Environmental Health Hazard Assessment (http://www.oehha.ca.gov/fish/nor_cal/index.html). Adapted from Alpers and Hunerlach (2000) – USGS Fact Sheet FS-061-00

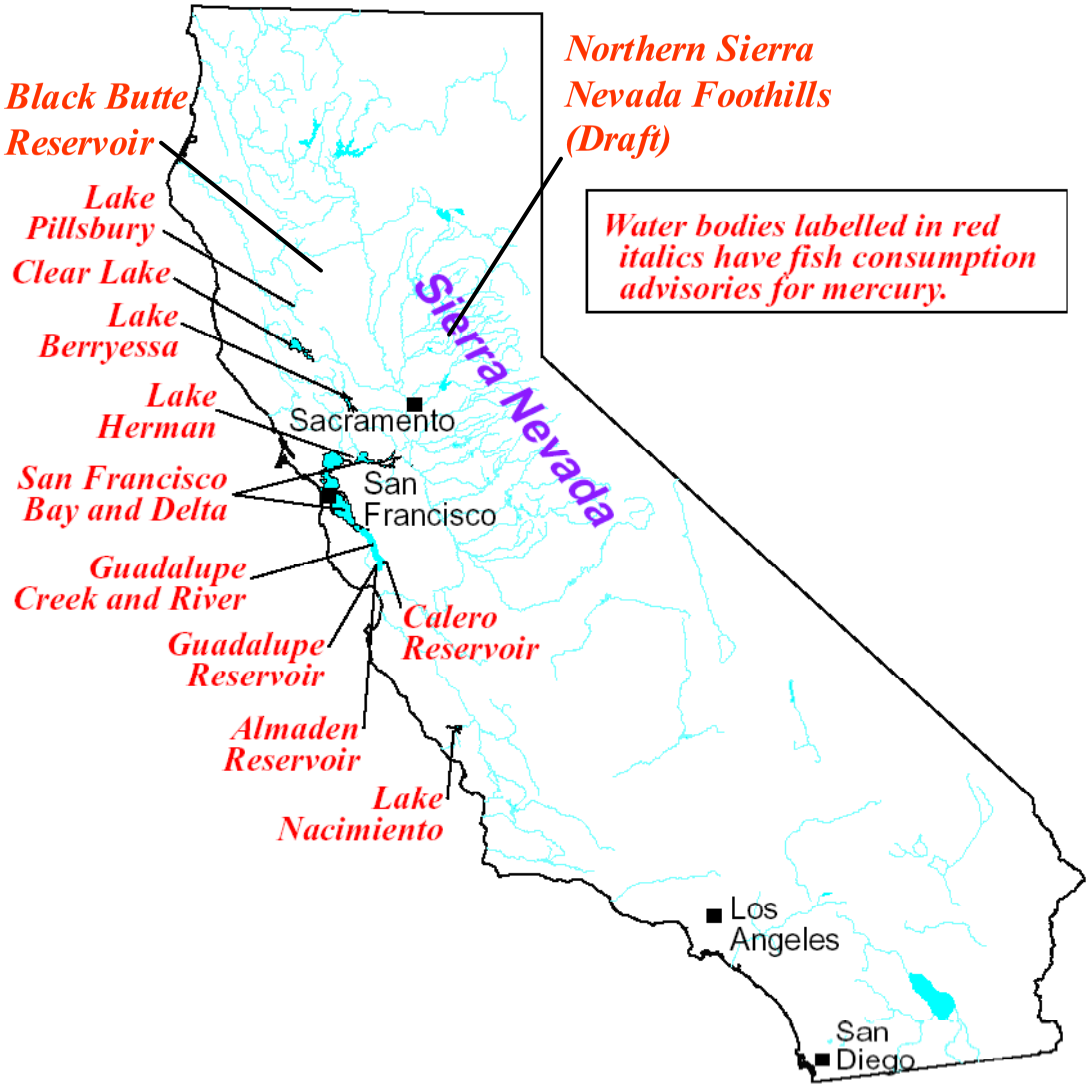


Figure 5. Location map of previous SFEI/MLML sport fish collection sites, including many potential candidate index sites for the proposed project. See Table 3 for actual list.

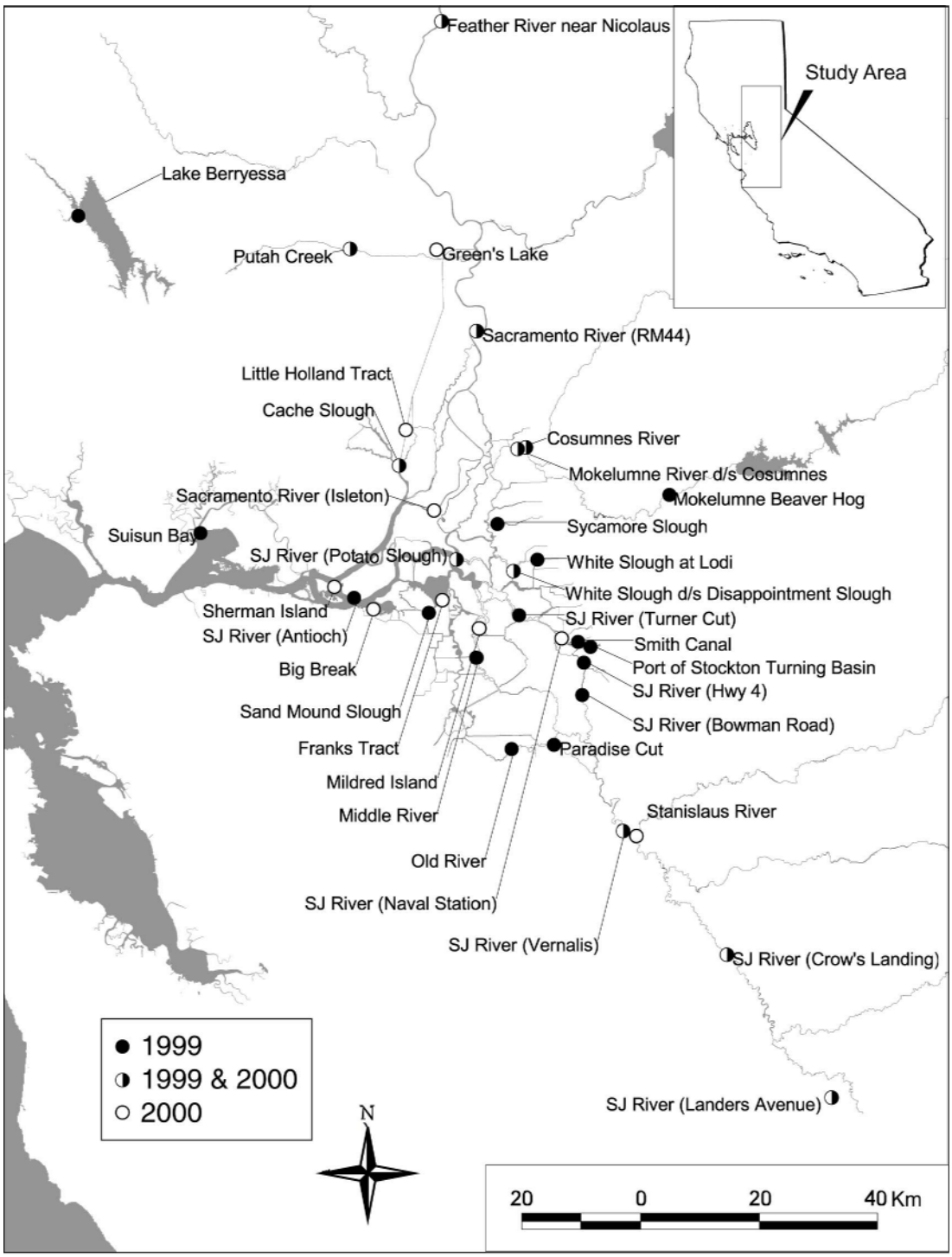
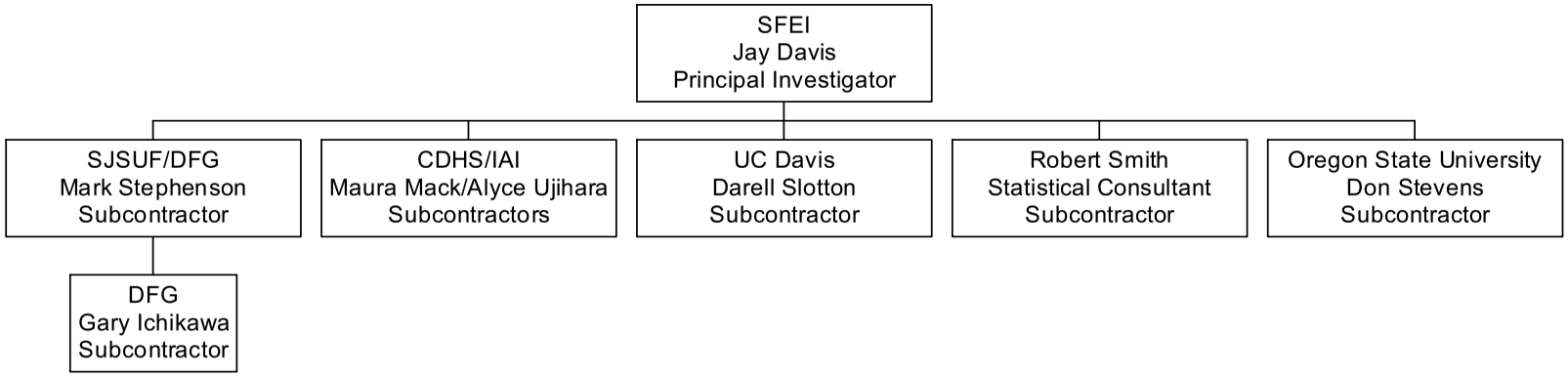


Figure 6. Organizational Chart.



Research, Outreach, and Education on Fish Contamination in the Sacramento – San Joaquin Delta and Tributaries (AKA Delta Fish Project)

Phase I Needs Assessment Final Report

January 2004

Environmental Health Investigations Branch
California Department of Health Services

EXECUTIVE SUMMARY

Mercury, a potent neurotoxin, bioaccumulates in fish in the Sacramento-San Joaquin Delta and tributaries watershed (hereafter referred to as the Delta watershed) at levels that may pose health risks to people who consume the fish. Mercury is prevalent in the Delta watershed due to human activities, such as historic mercury mining in the Coastal range and gold mining in the Sierra Nevada, and naturally occurring deposits. Mercury concentrations in several species of fish at many locations in the Delta watershed exceed the health-based screening values set by the U.S. Environmental Protection Agency. The Environmental Health Investigations Branch (EHIB) of the California Department of Health Services is the lead agency coordinating the Delta Fish Project, an interagency effort to reduce exposure to mercury in populations that consume fish caught in the Delta watershed. During August 2002-September 2003, EHIB conducted a needs assessment in five priority counties in the Delta watershed: Lake, Sacramento, San Joaquin, Placer, and Yolo. The counties were selected based primarily on the following criteria: (1) high levels of mercury in fish, and (2) high levels of fishing activity. The purpose of the assessment was to identify specific populations that consume fish caught in the Delta watershed, and to determine fish contamination awareness, concerns, and information needs of county health and environmental health departments, Native American tribes, and community-based organizations (CBOs) and health care providers that serve populations who consume fish from the watershed.

Needs assessment findings include the following: (1) while county health and environmental health departments believe that local fish contamination is a public health concern, they are not undertaking public outreach and education activities, in large part due to competing public health needs that are a higher priority for these counties, (2) Pomo Indian tribal members reported that some members fish in local waterbodies and consume their catch while others do not due, in large part, to a belief that the waters are polluted with mercury and other contaminants, (3) health care providers are not aware of any concern among their patients about mercury contamination of fish, and (4) members of Southeast Asian, Latino, African-American, and Russian communities regularly eat fish, especially striped bass and catfish, from local waters, and have generally low awareness of fish consumption advisories and the health risks of exposure to mercury in fish. EHIB recommends the following: (1) develop and disseminate outreach and education messages and materials in collaboration with local government agencies, tribes, and CBOs, (2) use visual images (e.g., pictures, posters, calendars, and videos) and mass media (e.g., television and radio) to effectively communicate messages to target populations, (3) collaborate with health care providers (i.e., family practice physicians, obstetricians, gynecologists, pediatricians, physicians assistants, and nurse practitioners) to inform target populations, especially women of childbearing age, and (4) evaluate outreach and education activities on an ongoing basis to ensure the effectiveness and appropriateness of messages, materials, and communication methods.

Full Report Available from Alyce Ujihara, EHIB (AUjihara@dhs.ca.gov)

ATTACHMENT 2

REGIONAL BIOSENTINEL EXAMPLES

Fig. 1. Small fish biosentinel data across the Delta region *(from Slotton et al. 2002a)*

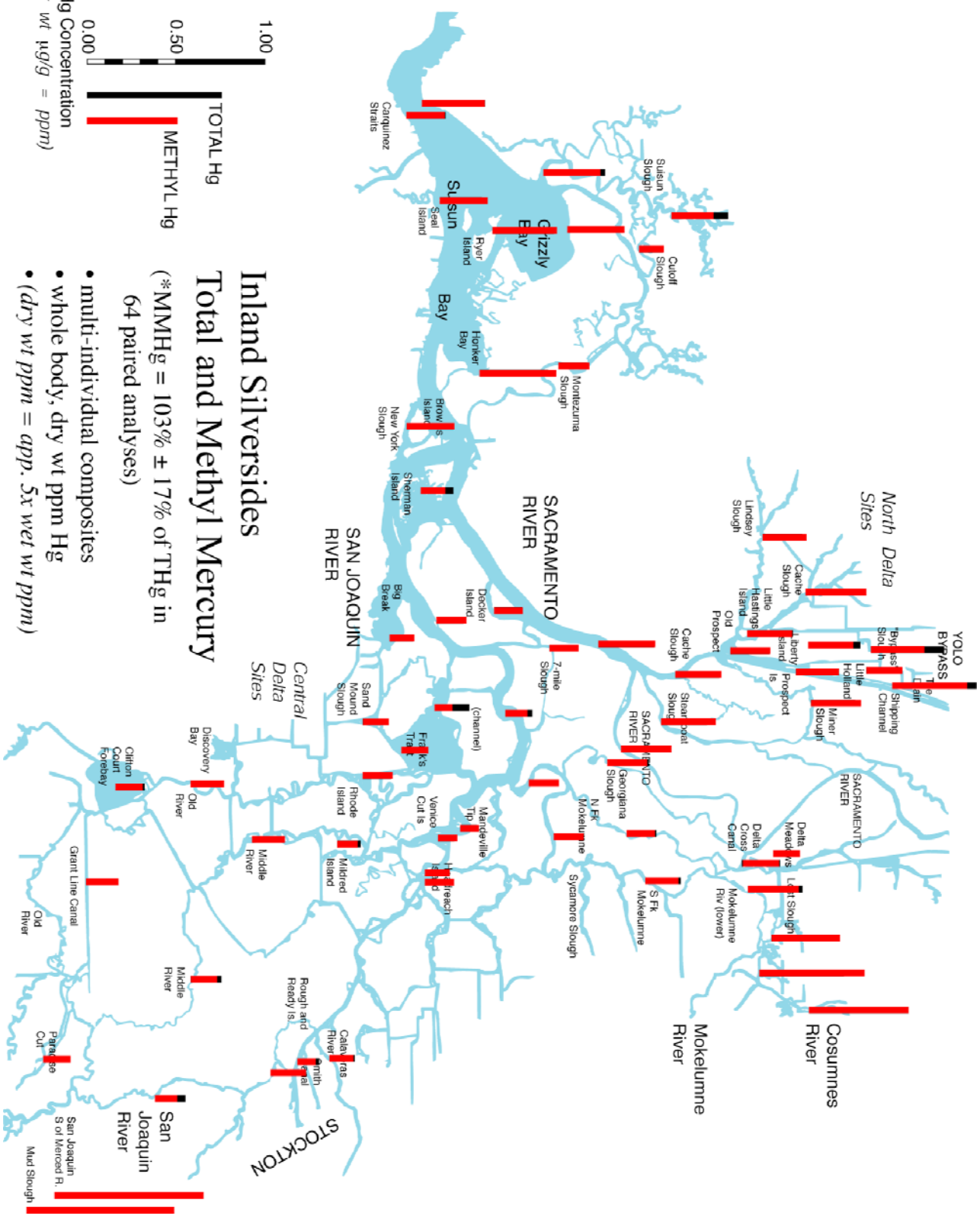
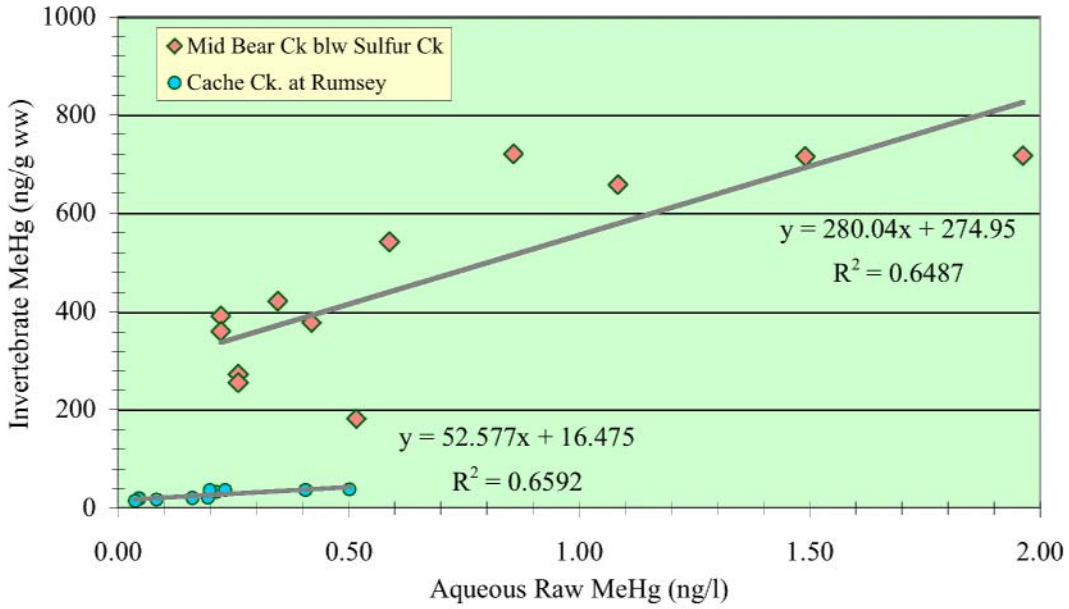


Figure 2. Examples of correspondence between aqueous MeHg and biosentinel MeHg. Comparative site-specific relationships at two divergent Cache watershed sites. (a) vs. mixed predatory invertebrates (b) vs. small omnivorous fish *(from Slotton et al 2004a)*



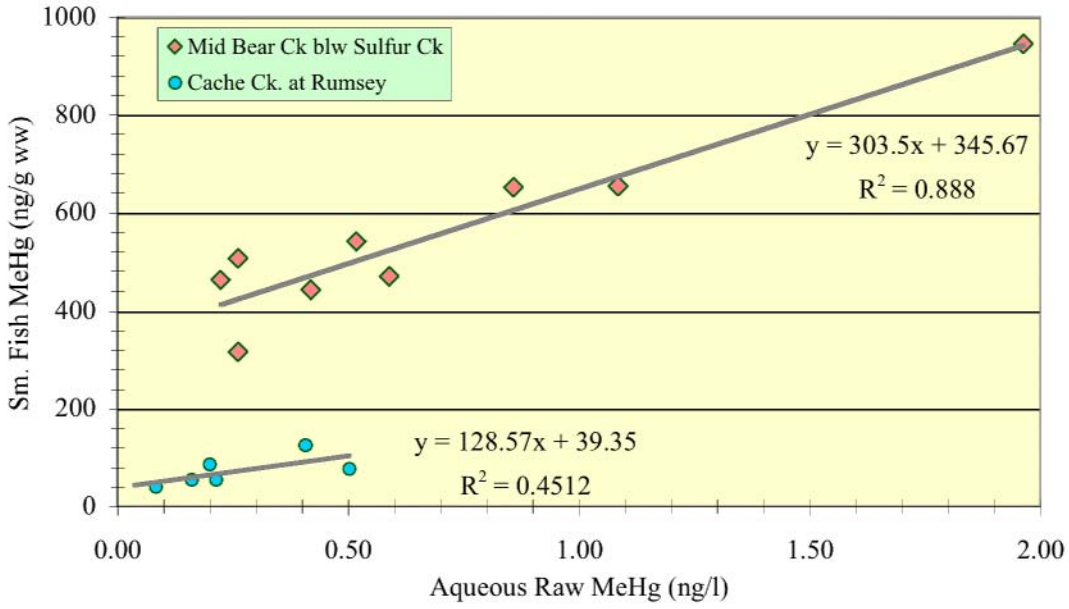


Figure 3. Examples of correspondence between biosentinel MeHg and large fish Hg. Linear regressions of temporally pooled site data for aquatic insect MeHg and small fish MeHg vs piscivorous large fish (270 mm normalized) and adult Sacramento sucker (290 mm normalized) fillet muscle Hg. Cache Creek watershed. *(from Slotton et al. 2004a)*.

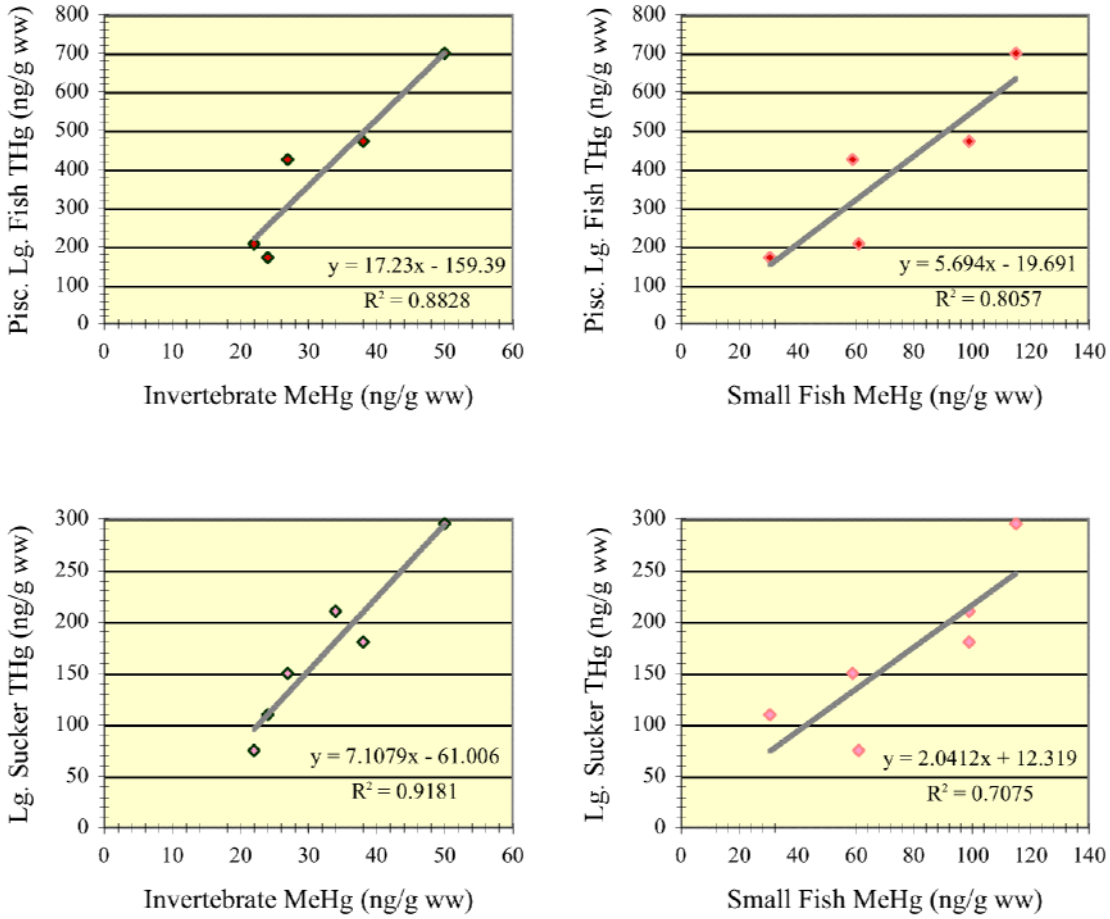


Figure 4. Examples of correspondence between biosentinel aquatic insect MeHg (Hydropsychid caddisflies, Perlid stoneflies), biosentinel juvenile rainbow trout MeHg (*Oncorhynchus mykiss*), and adult rainbow trout fillet muscle Hg (250 mm normalized). Yuba river watershed. *(from Slotton et al. 2003b)*.

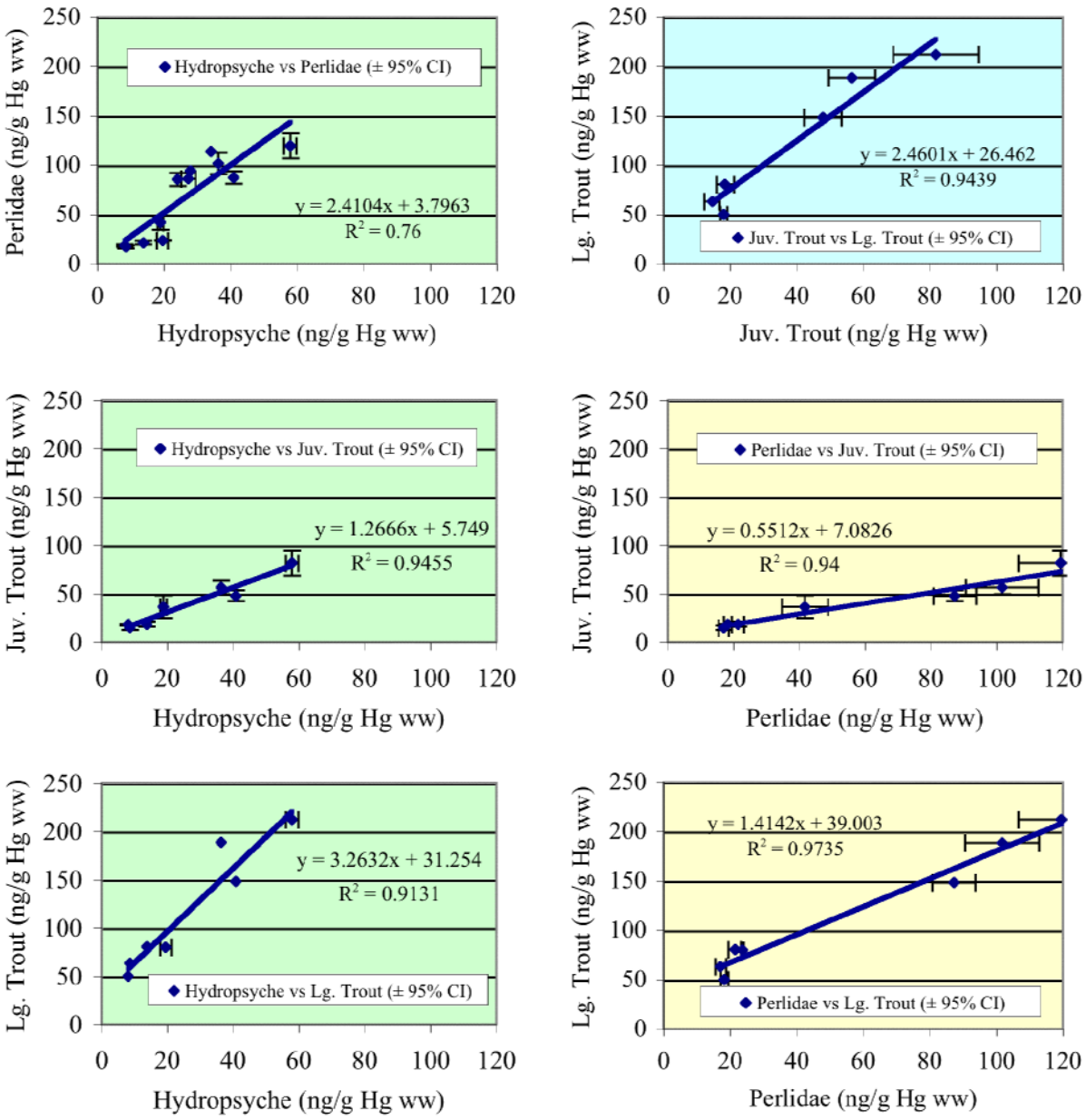


Figure 5. Spatial Hg bioaccumulation trend across Yuba watershed mining zone. Reduced site data for trout and primary insects. Mean MeHg and THg ±95% confidence intervals. Adult and juv. trout: condensed from app. 15 ind. analyses per site. Insects: means of 1-4 multi-individual (high n) composites per site. *(from Slotton et al. 2003b)*.

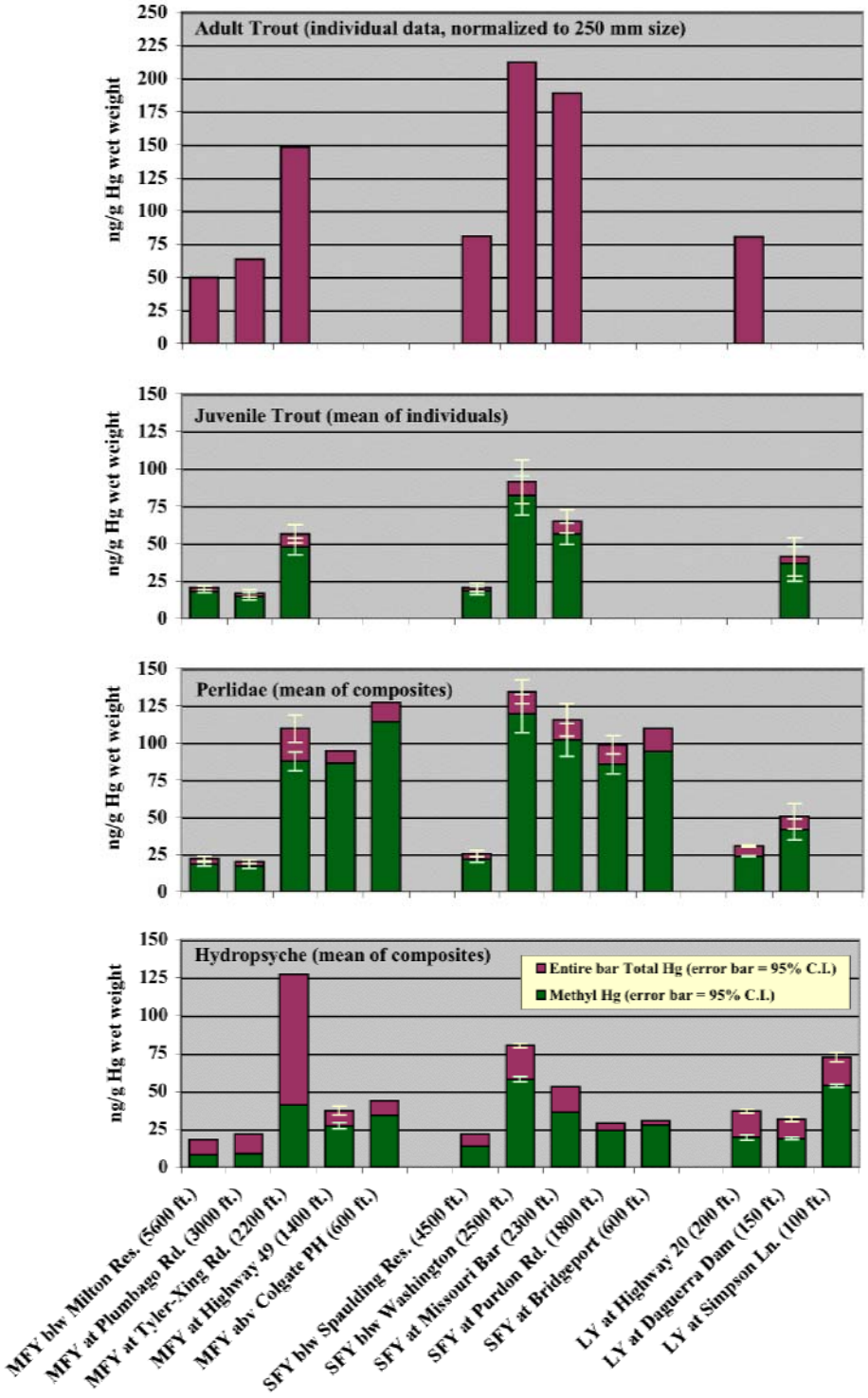
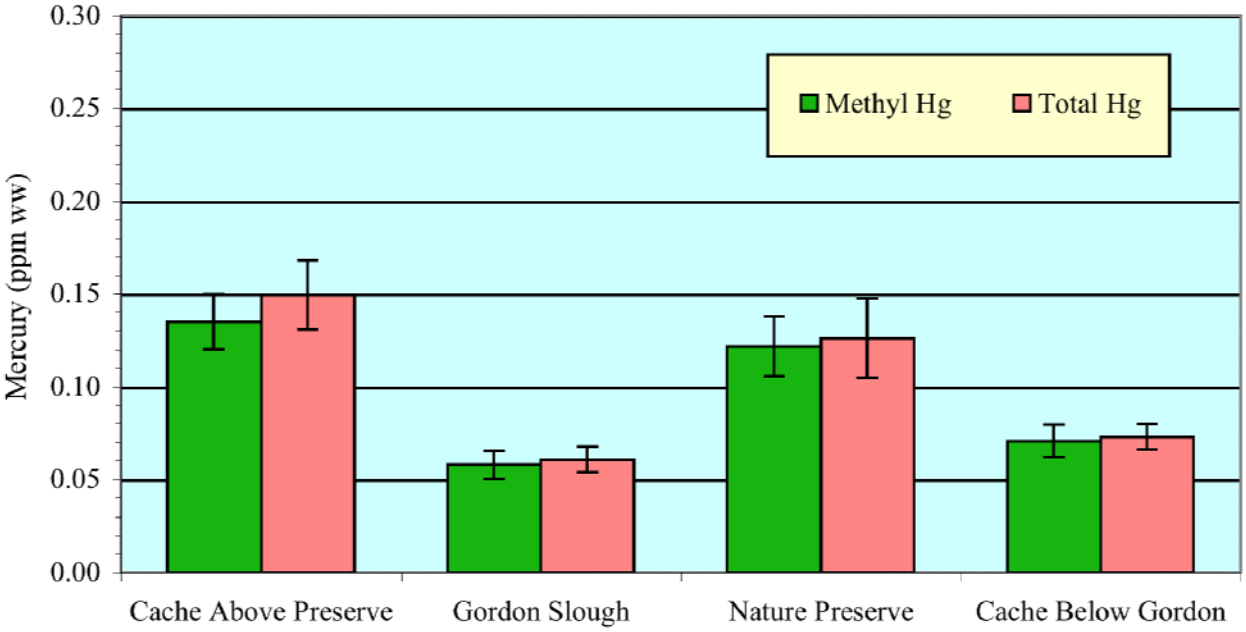


Figure 6. Small fish biosentinel measures of (A) spatial and (B) temporal (seasonal) Hg bioaccumulation trends in relation to a created wetland in Yolo County ("Nature Preserve"). ± 95% statistical confidence intervals. Note elevated Hg bioaccumulation in Nature Preserve relative to Gordon Slough source water. Note significant seasonal flux in net bioaccumulation. *(from Slotton et al. 2003a)*.

(A) Spatial Trends (20-30 mm *Gambusia*, November, 2002)



(B) Seasonal trends in small fish biosentinels, Nature Preserve wetlands, Fall 2000 – Fall 2002

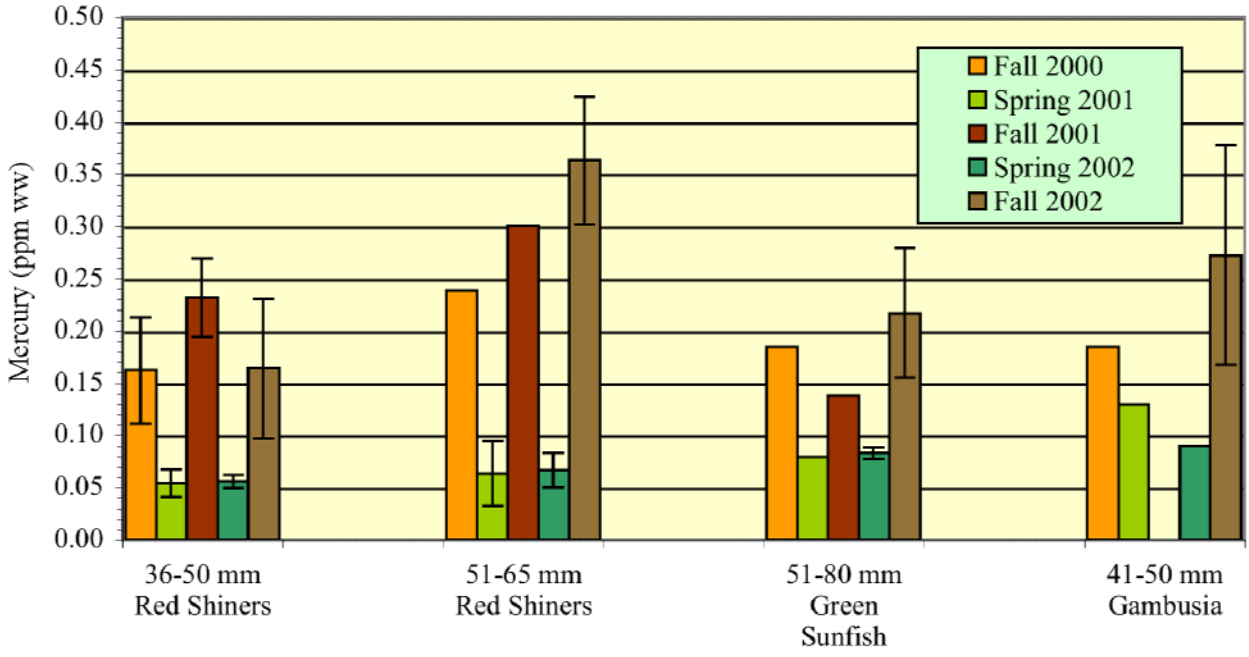


Figure 7. Biosentinel small fish demonstrating spatial trends in MeHg exposure in two small creeks associated with historic dredge tailings in the Lake Natoma watershed (American River). Whole body methylmercury in juvenile smallmouth bass *(Micropterus dolomieu)* and juvenile largemouth bass *(Micropterus salmoides)* from project sampling sites. Means of approximately 15 individuals analyzed per site, ± 95% statistical confidence intervals.
(from Slotton et al. 2004c).

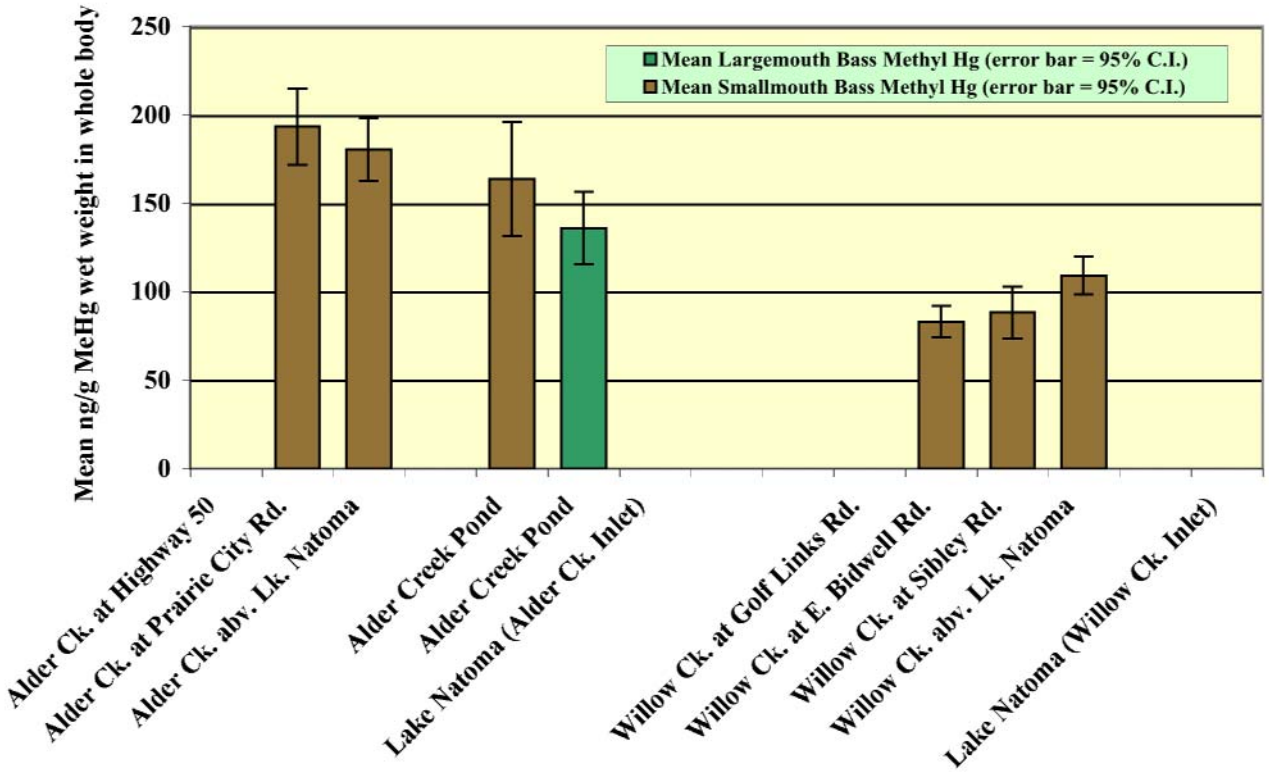
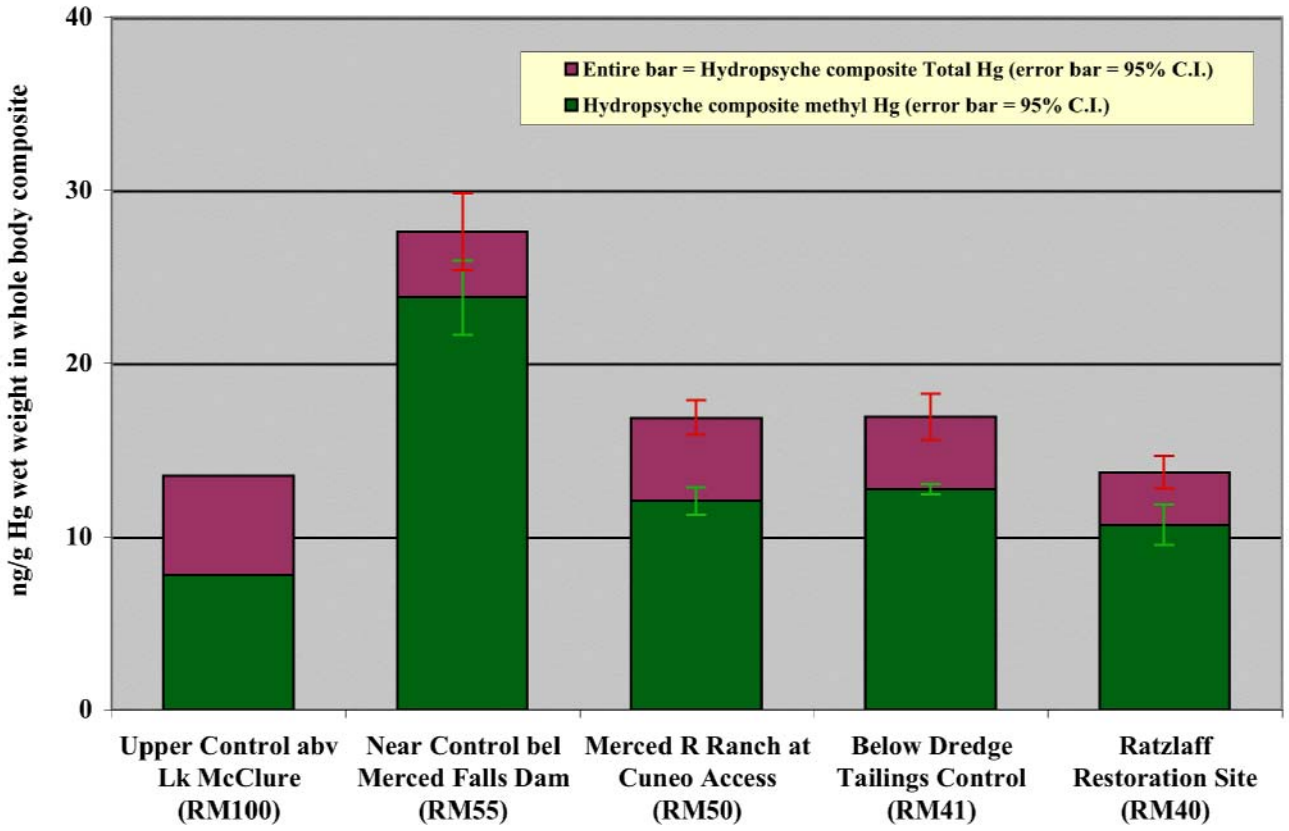


Figure 8. Biosentinel aquatic insects demonstrating spatial trends in Hg exposure in relation to historic dredge tailings of the Merced River (these tailings found to be low in Hg). Hydropsychid caddisfly samples, mean MeHg and THg in quadruplicate, multi-individual (n=40) composites, with 95% confidence intervals. RM = river mile. *(from Slotton and Ayers 2004b)*.



LINKAGE TO OTHER RESEARCH, MONITORING, AND RESTORATION PROJECTS

Research Projects

Two major mercury research projects selected for funding to date by the Bay-Delta Authority will have significant linkages with the proposed work. In 2003 the Bay-Delta Authority funded a mercury mass loading study entitled, "Transport, Cycling and Fate of Mercury and Monomethylmercury in the San Francisco Delta and Tributaries—An Integrated Mass Balance Assessment Approach" which will study aqueous mercury mass balances and cycling in the Delta. This study includes a wetland component that will determine mercury mass loads from approximately 10 wetlands. We propose in this new study to investigate bioaccumulation processes in the same wetlands at the same time as the existing project. The water and sediment mercury data from this project can be compared with the fish mercury data from the proposed work to provide for interpretation of the processes involved in bioaccumulation. Investigators from Moss Landing Marine Labs are involved in both the existing project and the proposed project. In addition, principal investigators from this project are working with managers of CBDA restoration project managers in providing immediate support in terms of determining methyl mercury exports from their wetlands, thus ensuring coordination with restoration projects.

A second project, "Evaluation of Mercury Transformations and Trophic Transfer in the San Francisco Bay/Delta: Identifying Critical Processes for the Ecosystem Restoration Program" is investigating the relationship between sediment mercury concentrations and bioaccumulation in the food chain. This USGS project will investigate Hg in food chains at the Cosumnes River and Franks Tract and will focus primarily on bioaccumulation at the base of the food chain. Our work will focus on bioaccumulation in low to mid trophic level biosentinel species together with legal-sized game fish at the top of the food chain and will sample these same locations. In combination, data from the two projects can be used to provide a very detailed complementary description of mercury in representative Delta food chains. Coordinated, overlapping data from the biosentinel species will provide crossover linkage that may be used to help extend the findings of the process study across some of the wider monitoring network. Conversely, process study findings may help with the interpretation of monitoring data from sites beyond the paired sampling locations.

The CBDA is funding a project led by SFEI titled "Mercury and Methylmercury Processes in North San Francisco Bay Tidal Wetland Ecosystems." This project includes sampling of mercury in tidal marshes along a salinity gradient up the Petaluma River. Fish sampling in this project is a nexus with the biosentinel monitoring of restoration sites and index sites in the present proposal. Target fish species in the Petaluma marsh project include inland silversides and other species that may be sampled in the present study (gobies and sculpins). Findings of this work will inform and be integrated with the findings from the present project.

The CBDA is funding a project led by USFWS titled "Mercury in San Francisco Bay-Delta Birds: Trophic Pathways, Bioaccumulation and Ecotoxicological Risk to Avian Reproduction." This project will focus on mercury accumulation in birds primarily in San Francisco Bay in areas that do not overlap with the present project. However, additional information on primary prey organisms of studied bird species will be of great relevance to the monitoring program, particularly in relation to the choice of appropriate biosentinel species for different regions. The monitoring program will in turn provide extensive body burden data for a number of bird prey items, even if from adjacent regions.

Monitoring Programs

This project will also be closely coordinated with other monitoring programs. The Sacramento River Watershed Program has analyzed sport fish for the past 7 years in the Sacramento River and its tributaries. Funding for this work has waxed and waned. It presently appears that sampling will not occur in 2004, but may occur in 2005 and 2006 with funding from the State Water Resources Control Board Consolidated RFP. Both SFEI and Moss Landing Marine Lab are involved with the SRWP, with Dr. Davis leading the Fish Focus Group that designs the sport fish sampling element. We will insure there is no unnecessary duplication of effort between the SRWP and the proposed work.

The State of California has initiated a new bioaccumulation program as part of the Surface Water Ambient Monitoring Program (SWAMP). The proposed research can be integrated with this program easily because the same SFEI and Moss Landing Marine Labs staff involved in this proposal will be on the advisory committee that decides the sampling plan for the SWAMP program. In addition, SFEI will be assisting SWAMP in establishing an organizational structure and in reviewing past bioaccumulation monitoring data statewide (State Mussel Watch, Toxic Substances Monitoring Program, Coastal Fish Contamination Program). This data review will provide valuable background for the Program described in this proposal, and has reduced the cost of this proposal by eliminating some of the literature review work that was included in the previous submittal.

The San Francisco Estuary Regional Monitoring Program for Trace Substances (RMP) measures mercury in fish and other matrices in San Francisco Bay. There will be little overlap between this project and the RMP due to the spatial separation and different species sampled. One area of overlap is striped bass sampling. The RMP samples fish on a 3 year cycle, with the next round in 2006. Striped bass samples from the Bay collected for the RMP will be directly comparable to the large sample of striped bass to be collected from the Delta in 2006 in this project. The RMP is considering adding an element to sample a "one year old yellow perch" analog in the Bay for assessing spatiotemporal patterns. The challenge is selecting a species or suite of species that are broadly distributed and have the other properties desired in a mercury indicator. This may turn out to be another area of overlap. Dr. Davis is the manager of the RMP, so continued coordination between the RMP and this project is assured.

CBDA has funded a project entitled "Regional Wetland Monitoring Project" (Stuart Siegel principal investigator) to evaluate and characterize 7 wetland sites. They have not proposed mercury work but are evaluating the wetlands on the basis of biological, hydrological and chemical processes. We propose linking our project with this project at Brown's Island and perhaps Napa Salt Ponds and Petaluma Marsh.

Restoration Projects

Napa River

Staff from Moss Landing Marine Labs as part of the CBDA project project "Transport, Cycling and Fate of Mercury and Monomethylmercury in the San Francisco Delta and Tributaries—An Integrated Mass Balance Assessment Approach" have been coordinating with managers from several restoration sites on the Napa River. One of these sites will most likely be selected as a study site to monitor methyl mercury exports. Likewise, if this project selects a Napa River restoration site to study, the site will probably also be selected by the proposed study. The researchers involved with the existing and proposed monitoring projects have already coordinated with the restoration managers in the area, and further coordination meetings are planned insuring strong linkages and coordination.

North Delta Improvement Project

A series of wetland restorations are underway or planned by DWR, ACE, CDFG, and other agencies. These include extensive habitat modification at Prospect Island, natural post-breach succession at Liberty and Little Holland Tracts, and development of new seasonal floodplain and tidal habitat at the McCormick-Williamson tract at the mouth of the Mokelumne River. Choice of breach locations is critical for this last project, as one side contains very high Hg inputs derived from the Cosumnes River, while another has been demonstrated to be a low Hg environment (Snodgrass Slough). However, the more natural floodplain design would utilize an upstream (high Hg) breach. UC Davis has studied Hg bioaccumulation and methylation in all of these areas and has been in contact with some of the lead restoration agencies, providing advice and planning potential collaborations related to restoration mercury monitoring. Further coordination is planned. It is expected that some of these sites, or closely linked locations, will be chosen for sampling in the proposed work, continuing the existing coordination.

Dutch Slough

Large land purchases have been made in this region, intended for intensive wetlands restoration. A potentially serious confounding factor is the presence of a significant abandoned mercury mine on Mt. Diablo, directly upstream in the Marsh Creek watershed. UC Davis researched the Mt Diablo Mine and Marsh Creek watershed from 1995 through 1998 and has remained in contact with some of the groups funded for new work there, including the Natural Heritage Institute. Staff from Moss Landing Marine Labs as part of the CBDA project project "Transport, Cycling and Fate of Mercury and

Monomethylmercury in the San Francisco Delta and Tributaries—An Integrated Mass Balance Assessment Approach" have been coordinating with managers from the Dutch Slough restoration project. This will most likely be selected as a study site to monitor methyl mercury exports. Likewise, if this project selects a Dutch Slough restoration site to study, the site will probably also be selected by the proposed study. The researchers involved with the existing and proposed monitoring projects have already coordinated with the restoration managers in the area, and further coordination meetings are planned insuring strong linkages and coordination.

Yolo Bypass

Several habitat manipulation projects are ongoing in this area. The Yolo Bypass has been shown to be a substantial conduit of Hg from Cache Creek in the previous multi-institution CBDA mercury studies. USGS further demonstrated increased methylation once Hg enters Bypass wetland environments. Current collaboration is underway between Ted Sommer at DWR and Dr. Slotton at UC Davis, investigating mercury bioaccumulation in young-of-year Chinook salmon and splittail in the seasonally flooded Bypass environment, as compared to the adjacent Sacramento River. The prior CBDA proposal by UC Davis included a substantial focus on this region; it would also be an excellent addition to the list of restoration monitoring sites if agreed to by the Steering Committee. Staff from Moss Landing Marine Labs as part of the CBDA project project "Transport, Cycling and Fate of Mercury and Monomethylmercury in the San Francisco Delta and Tributaries—An Integrated Mass Balance Assessment Approach" have been coordinating with managers from several restoration sites in the Yolo Bypass. At least one of these sites will most likely be selected as a study site to monitor methyl mercury exports. Likewise, if this project selects a Yolo Bypass restoration site to study, the site will probably also be selected by the proposed study. The researchers involved with the existing and proposed monitoring projects have already coordinated with the restoration managers in the area, and further coordination meetings are planned insuring strong linkages and coordination.

Other Projects

The Delta Watershed Fish Project

There are linkages between the Delta Watershed Fish Project and the proposed work. EHIB has received funding from CBDA and others for Phase I of the Delta Watershed Fish Program. Phase I included needs assessments, formation of stakeholder advisory groups, and planning of fish consumption studies. EHIB anticipates additional funding from CBDA for continuation of Phase II of this project beginning this summer. Phase II will include support for the Delta Stakeholder Advisory Group, needs assessments, educational materials development, training, and evaluation. Many of these activities will overlap with this Pilot Program for Mercury in Fish, but this overlap will occur only during part of the first year. EHIB has reduced the year 1 funding of the Pilot Program to reflect this overlap. Phase II will also include studies to characterize and

quantify fish consumption practices in select populations in the Delta. Findings from this work will inform the selection of species and monitoring sites in the Delta.

Sampling Design for Temporal Trend Monitoring

Robert W. Smith

The goal of the long-term monitoring will be to detect changes in mercury levels over time for the target fish. Some aspects of the sampling design will depend on current knowledge or information to be obtained from the Pilot Program. Examples include what fish species to use, the sampling locations, whether to composite or not, etc. These issues are discussed in other sections of the proposal. This Attachment discusses statistical analyses for optimizing sampling design sensitivity given the available resources. The approach outlined below will be applied to both the sport fish and biosentinel data where longer time series are expected. In Attachment 4, power analyses for spatial and short-term comparisons are discussed for the biosentinel monitoring. Where short-term or spatial changes are of interest, the same power analyses described in Attachment 4 can be used for the sport fish.

The Statistical Model

The sampling design affects the sensitivity of the statistical tests used to meet the monitoring goals. To quantify the relationship between the sampling design and the statistical tests, the statistical model of the statistical test must be first explicitly defined. In the proposed study, we will use a simple linear regression model described in Fryer and Nicholson (1993) to detect linear trends over time. In the model, the dependent variable is the mean level of mercury for a year and the independent variable is the year. The null hypothesis of the test is that there is no linear change in the mercury levels over time. This model assumes the presence of random between-year variance, which is appropriate, since some cases of relatively high interannual variability in the mercury concentrations have been previously observed (Davis et al. 2003).

Although we are using a linear regression model, there may be non-linear changes over time. Unfortunately, the potential forms of non-linearity are infinite, making it difficult and risky to formulate specific non-linear regression model. If it seems appropriate, we may in fact use non-linear models when analyzing future results. However, to perform power tests (see below), we need to define desired effect sizes in terms of the regression model parameters (e.g. regression slopes), and this would be impossible without a very specific non-linear regression model in mind.

Power Tests

For the present statistical model, we are interested in detecting a non-zero regression slope, which indicates linear changes in mercury levels over time. The power of a statistical test is the probability that the test will detect an effect of a desired size, given the sampling design parameters, the sizes of the pertinent variance components in the data, and the nominal type-1 error level. The sampling design parameters are the

numbers of fish sampled each year, the number of years, and the time interval between sampling years. The variance components of interest are the within-year and the between-year random variabilities of mercury concentrations. Fryer and Nicholson (1993) provide the methodology for computing the power of a test, given the effect size, the sampling design parameters, the variance components estimates, and the nominal type-1 error.

The power analyses will involve computing the power for alternate sampling designs by varying the numbers of years, temporal spacing between years, numbers of fish sampled per year, and nominal type-1 error levels. Graphical displays of the results will show the relative benefits of the different designs, which in turn will be helpful in determining designs that provide the most efficient use of available resources.

If the mercury measurement is from a composite sample, then only a single measurement is available for each survey at a location. In this case, the power analysis is run with one observation per year and no within-year variance component can be estimated. The effects of the level of replication in the composite will be incorporated into the between-year variance. If feasible, the within-year variance component could be estimated if at least two composites are analyzed at each location-time. The advantage of this latter approach is that the power analysis could be used to help determine a sufficient level of replication within the composite samples (for the long-term monitoring).

The power tests require at least two years of data with multiple fish sampled each year to compute the between-year and within-year variance component estimates needed for the power tests. Currently, for sport fish there is only a single year of appropriate data available, so the power test analyses will need to be delayed until the first year of data become available. In the meantime, we will need to estimate levels of change that might occur over time (in terms of sizes of regression slopes) in the study areas. The power-test analyses will show whether a reasonable sampling design can be produced for detecting such changes within an acceptable time period.

Literature Cited

Davis, J. A., Greenfield, B. K., Uchikawa, G., and Stephenson, M. Mercury in Sport Fish from the Delta Region. 2003. San Francisco Estuary Institute, Oakland, CA.

Fryer R. J. and M. D. Nicholson. 1993. The power of a contaminant monitoring programme to detect linear trends and incidents. International Council for the Exploration of the Sea (ICES) Journal of Marine Science, **50:**161-168.

POWER ANALYSIS FOR BIOSENTINEL MONITORING

In addition to regression-based, long-term trend analysis, as described in Attachment 3, biosentinel sampling has the potential to define statistical differences between any two samplings, both spatially and temporally. We undertook an analysis of replication and associated statistical confidence with small fish biosentinel data from several recent projects (Table 1 below). We selected a goal for the biosentinel monitoring to be able to associate a 95% level of statistical confidence with environmental differences in mean biosentinel concentrations on the order of 25%. Thus, if mean concentrations between sites or dates differ by 25% or more, we will be able to show that this level of change is statistically significant. For this level of precision, sufficient replication is needed for each sample such that the absolute value of two times the calculated (1 sided) 95% confidence interval is less than or equal to 25% of the corresponding mean concentration. For a wide range of small fish species, both in the Estuary and in the tributaries, 15 replicate individuals were sometimes insufficient to provide statistical separation of environmental differences of 25% or less. An analysis of replication efficiency with the primary target species, inland silverside, indicated that individual variability at some sites required as many as 25 replicates in order to statistically differentiate environmental differences of 25% or less.

Based on this information, our biosentinel protocol will include, as available, up to 30 replicate whole individual small fish within a consistent size range for each sample, to be analyzed individually for total mercury. The methyl:total mercury ratio will be assessed for each sample with a composite comprised of equal parts of homogenized portions from each of the individuals, analyzed in triplicate. For any supplemental aquatic invertebrate biosentinel sampling, several recent projects within Bay-Delta tributaries have refined the use of triplicate or quadruplicate composites, each consisting of multiple (n>20) whole individuals, analyzed for both methyl and total mercury. This approach, with Hydropsychid caddisflies in particular, has provided a very sensitive and widely available alternate measure of relative methylmercury exposure in tributary streams. Representative data are presented at the end of Table 1 below.

Table 1. *(following pages)* **Examples of CBDA region small fish biosentinel individual replication vs. statistical confidence of mean mercury concentration** *(UC Davis data from multiple recent projects)***.**

(a) Inland silverside statistics relative to increasing individual replication from selected sites.
(b) Inland silverside, other small fish, and Hydropsychid caddisfly statistics associated with representative samplings.

Replication sufficient to statistically differentiate a 25% environmental change in mean mercury concentration highlighted in bold.

Number of Fish	Mean Hg Concentration µg/g dry weight	95% Confidence Interval	Confidence Interval % of mean Hg Conc.	2X C.I. % of mean
	Sherman Island Silversides (December 10, 1999)			
5	0.174	± 0.012	7.1%	**14.1%**
10	0.179	± 0.007	4.0%	**8.0%**
15	0.180	± 0.010	5.4%	**10.7%**
20	0.175	± 0.009	5.3%	**10.7%**
25	0.175	± 0.008	4.6%	**9.2%**
30	0.175	± 0.008	4.5%	**9.0%**
35	0.177	± 0.008	4.3%	**8.6%**
	Grizzly Bay Silversides (December 13, 1999)			
5	0.246	± 0.091	36.8%	73.5%
10	0.262	± 0.038	14.7%	29.4%
15	0.251	± 0.031	12.2%	**24.4%**
20	0.269	± 0.028	10.6%	**21.2%**
25	0.277	± 0.027	9.9%	**19.8%**
30	0.278	± 0.026	9.5%	**19.0%**
	Old Prospect Slough Silversides (October 12, 1999)			
5	0.246	± 0.091	36.8%	73.5%
10	0.238	± 0.038	15.8%	31.6%
15	0.226	± 0.030	13.5%	26.9%
20	0.233	± 0.027	11.6%	**23.3%**
25	0.229	± 0.023	9.8%	**19.7%**
30	0.235	± 0.022	9.6%	**19.1%**
	Little Holland Tract Silversides (October 13, 1999)			
5	0.191	± 0.018	9.2%	**18.3%**
10	0.188	± 0.013	6.9%	**13.9%**
15	0.191	± 0.018	9.2%	**18.4%**
20	0.189	± 0.013	6.8%	**13.7%**
25	0.188	± 0.010	5.6%	**11.1%**
	Sacramento River above Isleton Silversides (December 8, 1999)			
5	0.273	± 0.087	31.8%	63.6%
10	0.231	± 0.048	20.9%	41.9%
15	0.237	± 0.039	16.2%	32.5%
20	0.250	± 0.035	14.1%	28.2%
25	0.260	± 0.031	12.1%	**24.2%**
30	0.262	± 0.028	10.6%	**21.2%**
35	0.259	± 0.024	9.3%	**18.6%**
	San Joaquin River at Bowman Road Silversides (October 8, 1999)			
5	0.146	± 0.048	32.8%	65.6%
10	0.147	± 0.020	13.7%	27.4%
15	0.147	± 0.014	9.8%	**19.6%**
20	0.148	± 0.011	7.6%	**15.1%**
25	0.147	± 0.010	6.7%	**13.5%**
30	0.150	± 0.009	6.1%	**12.1%**
35	0.149	± 0.008	5.3%	**10.6%**
	Mildred Island Silversides (November 9, 1999)			
5	0.123	± 0.031	25.2%	50.4%
10	0.119	± 0.023	19.3%	38.5%
15	0.125	± 0.016	12.8%	25.6%
20	0.124	± 0.013	10.1%	**20.3%**
25	0.126	± 0.014	11.0%	**22.0%**

Number of Individuals	Mean Hg Concentration µg/g dry weight	95% Confidence Interval	Confidence Interval % of mean Hg Conc.	2X C.I. % of mean
	Silversides, Cosumnes-North Slough (October 26, 1999)			
15	0.340	± 0.033	9.8%	**19.5%**
	Silversides, Suisun Slough near Suisun City (December 14, 1999)			
13	0.328	± 0.056	17.0%	34.1%
	Silversides, Delta Meadows (October 28, 1999)			
19	0.137	± 0.013	9.7%	**19.5%**
	Silversides, Honker Bay (December 13, 1999)			
19	0.382	± 0.039	10.1%	**20.2%**
	Logperch, Cosumnes-North Slough (October 26, 1999)			
18	0.262	± 0.036	13.8%	27.5%
	Threadfin Shad, Sacramento River at Decker Island (September 27, 1999)			
15	0.128	± 0.025	19.3%	38.5%
	Largemouth Bass, San Joaquin River near 7-mile Slough (September 28, 1999)			
15	0.144	± 0.019	12.9%	25.8%
	Golden Shiners, Old River at Highway 4 (November 9, 1999)			
15	0.058	± 0.009	14.7%	29.4%
	Yellowfin Goby, Cutoff Slough (September 9, 1999)			
15	0.109	± 0.019	17.6%	35.2%
	Gambusia, Cosumnes River Index Site near Preserve (October 26, 1999)			
10	0.600	± 0.105	17.6%	35.2%
	Red Shiners, Mud Slough (December 2, 1999)			
15	0.708	± 0.138	19.6%	39.1%
	California Roach, Davis Ck. above Davis Ck. Res. (August 20, 2001)			
10	0.269	± 0.045	16.8%	33.6%
	California Roach, Davis Ck. below Davis Ck. Res. (August 20, 2001)			
12	0.315	± 0.023	7.4%	**14.9%**
	Prickly Sculpin, Alder Ck. above Lake Natoma (June 19, 2003)			
15	0.084	± 0.007	8.3%	**16.7%**
	Prickly Sculpin, Willow Ck. above Lake Natoma, Sibley Rd. (June 17, 2003)			
15	0.041	± 0.004	9.8%	**19.5%**
	Hydropsychidae, Yuba River at Highway 20 (November 21, 2002)			
4 comps of 40 ea.	0.020	± 0.002	10.0%	**20.0%**
	Hydropsychidae, Yuba River near Marysville (November 21, 2002)			
4 comps of 40 ea.	0.054	± 0.001	1.9%	**3.7%**
	Hydropsychidae, Alder Ck. above Lake Natoma (June 16, 2003)			
4 comps of 40 ea.	0.069	± 0.005	7.2%	**14.5%**
	Hydropsychidae, Willow Ck. above Lake Natoma (June 16, 2003)			
4 comps of 40 ea.	0.060	± 0.004	6.7%	**13.3%**
	Hydropsychidae, Merced River at Merced River Ranch (October 29, 2003)			
4 comps of 40 ea.	0.012	± 0.001	8.3%	**16.7%**

SAMPLING AND ANALYTICAL METHODS

Sport Fish

Sport fish samples will be collected by electroshocking (with an e-boat), fyke nets, gill nets, or other methods. Samples will be stored and processed using non-contaminating techniques, following protocols established for the CALFED Mercury Project (Davis et al. 2003), RMP, and SRWP. Total mercury concentrations in sport fish muscle will be analyzed by MLML. Samples will be analyzed using a Perkin Elmer Flow Injection Mercury System (FIMS) with an AS-90 autosampler. Methylmercury in selected species 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). 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. The MLML analytical lab will participate in the QA program being established by the Bay-Delta Authority. As part of this program, splits of 5% of samples will be analyzed by an independent lab. Funds for this have been included in the budget. Sufficient tissue mass from each sample will be archived to allow for reanalysis.

Biosentinels (Small Fish)

Sample handling and analysis will follow procedures developed in prior work (Slotton et al 2002a,b). Small fish samples will be cleaned and quick frozen in water directly in the field, providing optimal, essentially fresh condition for analysis following archiving of up to one year. Prior to analysis, individual samples will be weighed and measured and then dried to constant weight and ground to a consistent powder. Moisture percentage will be carefully determined, facilitating the conversion of dry weight analyses to wet/fresh weight concentrations. Dry powder samples have proven ideal for reproducibility, sample archiving, and availability for ancillary analyses such as carbon and nitrogen stable isotopes. Aquatic invertebrate composite samples will be cleaned in the field and placed into pre-weighed clean vials, allowing determination of fresh weight, prior to processing as for small fish.

Samples will be analyzed for total mercury by UC Davis using a Perkin Elmer Flow Injection Mercury System (FIMS) with an AS-90 autosampler, following digestion under pressure at 90 °C in a mixture of concentrated nitric and sulfuric acids with potassium permanganate. Methylmercury will be analyzed by UC Davis by complexation with bromide in a copper sulfate / sodium bromide solution, followed by organic extraction into methylene chloride / hexane, and then acid digestion and FIMS analysis as for total mercury. Numerous blanks, aqueous standards, appropriate standard reference materials, field duplicates, method duplicates, continuing control standards, and matrix spikes will be digested and analyzed with each set of samples. The UCD analytical laboratory will participate in the QA program being established by the Bay-Delta Authority. As part of this program, splits of 5% of samples will be analyzed by an independent lab. Funds for this have been included in the budget. Sufficient tissue mass from each sample will be archived to allow for reanalysis.

MERCURY IN SPORT FISH FROM THE DELTA REGION (TASK 2A)

J.A. Davis and B.K. Greenfield
San Francisco Estuary Institute
Gary Ichikawa and Mark Stephenson
Moss Landing Marine Laboratory

EXECUTIVE SUMMARY

In spite of the popularity of the Delta as a fishing location, human health concerns raised beginning in 1971, the existence of a consumption advisory for the Bay, and recent concern over fish tissue contamination in the Sacramento River watershed, very little systematic sampling has been conducted in the Delta to evaluate human health risks associated with chemical contamination of fish tissue. This report documents the most detailed study of mercury contamination in sport fish from the Delta region ever performed.

The objectives of this study were, in order of priority:

- 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; and
- Evaluate important factors influencing mercury concentrations such as age/size and trophic position.

Key features of the sampling design aimed at meeting these objectives were 1) sampling of a wide variety of species and 2) analysis of mercury in individual fish for the primary target species.

Sampling was performed in late summer 1999 and 2000. Primary target species, including largemouth bass, white catfish, striped bass, and Sacramento pikeminnow, were analyzed as individuals. Secondary target species, including channel catfish, black crappie, Sacramento sucker, common carp, bluegill, and redear sunfish, were sampled as multi-individual composites. Measured concentrations were compared to a screening value for mercury, defined as a concentration in fish or shellfish tissue that is of potential public health concern. Exceedance of the screening value should be interpreted as an indication that more intensive site-specific monitoring and/or evaluation of human health risk should be conducted.

The principal conclusions of the study are:

- Several species (including largemouth bass, striped bass, Sacramento pikeminnow, channel catfish, and white catfish) had mercury concentrations of high human health concern, exceeding the screening value (0.3 ppm) in a majority of samples and frequently exceeding 1 ppm.
- Three species had mercury concentrations of moderate human health concern, including common carp, black crappie, and Sacramento sucker.
- Significant spatial variation exists in the watershed. Mercury concentrations in the Feather River, northern Delta, lower Cosumnes River, and San Joaquin River regions were

significantly elevated and in the 1 ppm range. Concentrations in the central Delta region were significantly lower than other locations, and usually below the screening value. These regional patterns were evident among several sport fish species. There was a precipitous drop in concentrations between nearby stations in the Central Delta.

- Mercury concentrations in striped bass, which are integrative indicators of mercury in the watershed, have not changed perceptibly in the past 30 years. Some striped bass samples collected for this study were high even relative to the concentrations measured 30 years ago.

THE FULL REPORT IS AVAILABLE AT:

http://loer.tamug.tamu.edu/calfed/Reports/Final/Task%202A%20-%20Text%20and%20Figures.pdf

The Effects of Wetland Restoration on the Production and Bioaccumulation of Methylmercury in the Sacramento-San Joaquin Delta, California

By

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Submitted in collaboration with the multi-institution Directed Action research project:

Assessment of Ecological and Human Health Impacts of Mercury in the San Francisco Bay-Delta Wateshed

A CALFED Bay-Delta Program Project
October 1999 – March 2003

DRAFT FINAL REPORT

September 25, 2002

ATTACHMENT 8

Abstract

Methylmercury (MeHg) production, export, and bioaccumulation were investigated at representative sites throughout the Sacramento-San Joaquin Delta in California, in relation to wetlands restoration efforts in the region. Sediment MeHg and MeHg:total mercury (THg) ratios were examined at paired sites inside and outside various flooded wetland tracts. Relative mercury (Hg) methylation potential was estimated in Hg-amended sediment slurry experiments. Concentrations of aqueous MeHg were assessed at a range of representative wetland tracts in inflowing vs outflowing water during tidal cycles. Relative biological Hg exposure levels throughout the region and spatially among habitats were assessed with naturally occurring small fish and invertebrate indicator species, which were tested for THg, MeHg, individual variability in Hg bioaccumulation, and nitrogen and carbon stable isotopic ratios.

Sediment MeHg concentrations and MeHg:THg ratios were found to be significantly greater in flooded tracts characterized by dense submergent or emergent aquatic vegetation, as compared to adjacent Delta channel, mudflat, or sandflat environments. Wetland sediments from vegetated flooded tracts exhibited 2-30 times greater potential to produce MeHg than aquatic sediments of adjacent channels and flats. At these same locations, concentrations of aqueous MeHg and aqueous MeHg normalized to suspended solids were found to be substantially elevated in outflowing tidal water (off the tracts), relative to inflowing water. Consistent with the literature for other estuarine systems, all of these measures indicated that highly vegetated, flooded wetland sediments functioned as net producers and exporters of MeHg to the wider Delta.

However, biological findings indicated no discernible localized increase in biotic MeHg concentrations in flooded wetland tracts vs adjacent aquatic habitats. Vigorous tidal action may effectively mix MeHg from net methylating habitats into local areas, creating larger spatial patterns. Most surprising was the finding of notably lowest overall Hg bioaccumulation throughout a broad region of the south and central Delta that contained numerous wetland restoration sites identified as net methylating environments. This indicates that the linkages between sediment MeHg, aqueous MeHg, and ultimate bioaccumulation by aquatic organisms may be quite complex. The regions with most highly elevated biotic Hg 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 Hg from historic gold mining in the Sierra Nevada and abandoned mercury mine cinnabar in the Coast Ranges appear to be of importance. This suggests that upstream remediation efforts on either side of the watershed may be more regionally meaningful than previously anticipated. A secondary zone of relatively elevated Hg bioaccumulation occurred in the estuarine entrapment / salinity transition zone.

THE FULL REPORT IS AVAILABLE AT:
http://loer.tamug.tamu.edu/calfed/DraftReports.htm

ADDITIONAL BIO SKETCHES

Gary Ichikawa, California Department of Fish and Game

Teaming with Dr. Davis, Mr. Ichikawa has managed sample collection and chemical analysis for various projects researching contaminant issues in the Bay-Delta in recent years. These projects investigated the accumulation of contaminants in fish and clams, including projects 1, 3, 4, and 5 listed under Dr. Davis, and the following:

- 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.

Alyce Ujihara, California Department of Health Services

Ms. Ujihara is a research scientist with the exposure assessment section at EHIB. For the past 10 years she has designed and conducted studies to characterize chemical exposures among fish consuming populations. She was Co-PI of the San Francisco Bay Seafood Consumption Study, and has conducted fish sampling studies on sport fish in Richmond Harbor and in commercial white croaker in San Francisco Bay. She has also provided technical assistance to the San Francisco Bay Seafood Consumption Task Force and the Palos Verdes Fish Contamination Task Force, and developed education and training materials on fish contamination issues. Currently she chairs an interagency planning group that is exploring options for conducting fish consumption studies in the Sacramento-San Joaquin Delta watershed.

Robert W. Smith, Independent Consultant

Dr. Smith is an ecologist and statistician with over 30 years experience consulting for environmental monitoring and field study programs. This work has involved participation in monitoring and statistical design, statistical analyses, database management, and computer programming. Clients have included regulators (U.S. EPA, California Regional and State Water Quality Control Boards), research organizations (San Francisco Estuary Institute, Southern California Coastal Water Research project), several private environmental consulting firms, and many regulated concerns including electric power generators, sanitation districts, and oil companies.

Some more recent projects relevant to fish and monitoring design are as follows:

- For Orange County and the Southern California Coastal Research Project, power analyses were applied in developing monitoring programs for southern California streams.

- For the cities of Los Angeles and San Diego, and the San Francisco Estuary Institute, power and optimization analyses were used to assist in the design of marine monitoring programs.
- For Pacific Gas and Electric, a computer program was developed for evaluation of model predictions of fish abundance in response to altered stream flows. Also, relationships between fish and limiting environmental parameters were evaluated using nonlinear regression techniques.
- For the San Francisco Estuary Institute, a computer program was developed for standardizing fish lengths with nonlinear analysis of covariance.
- For the U.S. EPA, fish and benthic infaunal response indices were developed to measure the effects of pollution. This work involved collaboration with the Southern California Coastal Water Research Project.

Dr. Don Stevens, Oregon State University

Since 1989, Dr. Stevens has been engaged in developing the statistical sampling theory supporting EMAP's spatially balanced probability sampling, and simultaneously applying that theory to sampling designs for lakes, streams, wetlands, estuaries, and forests. Some examples include a multi-year panel design for Coho salmon in Oregon coastal streams for the Oregon Department of Fish and Wildlife; a nested, multi-level design for sampling the Southern California Bight for the Southern California Coastal Water Research Project; a design to assess near-shore habitat in Puget Sound for the Washington Department of Natural Resources; a design to assess mercury contamination in the canals and marshes of South Florida; and the design currently being used by the San Francisco Estuary Regional Monitoring Program. He has a history of successful collaboration with both physical and biological scientists, with joint publications in disciplines such as aquatic ecology, wetland ecology, geography, limnology, geochemistry, soil science, forestry, radiation biology, aerosol physics, and veterinary medicine.