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:

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

August 1, 2003

_____

Authorized Signature

Donald Yee

_____

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

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

3. Corresponding Contact Person:
Donald Yee
San Francisco Estuary Institute
7770 Pardee Lane Oakland, CA 94621
510 559-9304
donald@sfei.org

4. Project Keywords:
Bioaccumulation
Geochemistry
Wetlands, Tidal

5. Type of project:
Research

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
Joint Venture

10. Location – GIS coordinates
Latitude: 38.177
Longitude: -122.505
Datum: (leave blank)

Describe project location using information such as water bodies, river miles, road intersections, landmarks, and size in acres.
The tidal wetlands along the Petaluma River

11. Location – Ecozone
2.4 Petaluma River, 2.5 San Pablo Bay

12. Location – County
Marin, Sonoma

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.
6

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

California State Senate District Number: 3
California Assembly District Number: 6

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.

SFEI does not use an overhead rate (see Comments under Indirect expense in budget justification)
$1,656,569

d. Do you have cost share partners <u>already identified</u>?

No

If yes, list partners and amount contributed by each.

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?

Yes

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

99N07 Chronic toxicity of environmental contaminants in Sacramento splittail CALFED Bay-delta Program

00-E04 Sonoma Creek Watershed CALFED Watershed Program

99-B06 Association of ecological and human health impacts withMercury in the Bay-delta CALFED Bay-delta Program

0145 Napa River watershed stewardship CALFED Bay-delta Watershed Program

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.

No

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

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:

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

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.

Wetland restoration projects are planned in areas in San Pablo Bay and Petaluma River. This will benefit the ecosystem, but in some cases existing mercury (Hg) contamination in restoration projects areas may negatively impact wildlife and humans unless steps can be taken to minimize such risks. Among the concerns are impacts on vertebrates linked closely with tidal marsh habitats which may accumulate potentially harmful concentrations of Hg, including the federal and state endangered California clapper rail, the state threatened California black rail, and the Virginia rail. Fishes that forage in or around wetland habitats may also accumulate mercury, impacting other wildlife and humans that consume those fish. A special concern with Hg is its biological transformations in the environment. Specifically, methylmercury (MeHg), formed by anaerobic bacteria such as found in wetland sediments, bioaccumulates and is more toxic than elemental and ionic forms of Hg produced or released by human activity. Parameters such as total Hg, salinity, sulfate, reduced sulfur, oxygen, temperature, redox, pH, and dissolved or total organic carbon have been demonstrated to influence net MeHg production. These may interact antagonistically or synergistically and can vary in an estuarine system spatially and on seasonal and daily temporal cycles. This project will examine Hg and MeHg concentrations in the sediments, water and biota of five tidal marshes along a salinity gradient up Petaluma River. Influences of seasonal and interannual variation in environmental parameters on Hg geochemistry and bioaccumulation will also be examined. Physiographic differences among marshes of different ages to be studied are also expected to impact Hg geochemistry. Relationships found previously in other estuarine ecosystems will be sought, and changes with marsh progression will be examined to project likely long-term outcomes of restoration projects. This knowledge is needed for deciding where and how to restore selected wetlands and to anticipate possible impacts of projects. For restoration projects that proceed, additional studies can then be conducted to confirm projected changes and further refine understanding of Hg transformation and bioaccumulation processes in an adaptive management process.

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 research project will not significantly impact the ecosystem.

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):

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

CEQA

- ☐ Categorical Exemption
- ☐ Negative Declaration or Mitigated Negative Declaration
- ☐ EIR
- ◉ none

NEPA

- ☐ Categorical Exclusion
- ☐ Environmental Assessment/FONSI
- ☐ EIS
- ☉ 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?
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

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 yes yes(obtained by USGS BRD for rail work)

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?**

No

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).

Research 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):

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

Subcontractor(s):

Are specific subcontractors identified in this proposal?

Yes

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

Jules Evens (Avocet Associates)

Helped with proposal development

Are there persons who helped with proposal development?

No

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

Ecosystem Restoration Program - 2002 Proposal Solicitation Package (PSP):
Form VI: Budget Summary
YEAR 1

Task	Job Titles	Labor Hours	Hourly rate	Hours X rate	Benefits	Travel	Supplies	Serv/ Consult.	Other Direct costs	Total Direct Costs	Indirect Costs	Total Year 1	Task Subtotal
1a.Project Coord/Mgmt	Env Scientist 1	120	99	11,880						11,880		11,880	
1b. Subcontracting	Env Scientist 2	40	130	5,196						5,196		5,196	
	Accountant	40	73	2,928						2,928		2,928	
	Contract Manager	80	79	6,312						6,312		6,312	
	subtotal												**26,316**
2a. Data Management	Env Analyst	120	63	7,560						7,560		7,560	
	System Analyst	40	71	2,850						2,850		2,850	
2b. Data Analysis/Reporting	Env Scientist 1	80	99	7,920	33					7,953		7,953	
	Env Scientist 2	40	130	5,196	43					5,239		5,239	
	Env Scientist 3	40	135	5,400	45					5,445		5,445	
	GIS analyst	40	105	4,200	35					4,235		4,235	
	Asst. Env Scientist	80	71	5,640	24					5,664		5,664	
	Env Analyst	80	63	5,040	21					5,061		5,061	
	subtotal												**44,007**
3a. Field Sampling and Prep						2,000	9,000	3,875		14,875		14,875	
	Env Scientist 1	120	99	11,880						11,880		11,880	
	Env Scientist 2	80	129	10,320						10,320		10,320	
	Env Scientist 3	120	135	16,200						16,200		16,200	
	Asst. Env Scientist	80	71	5,640						5,640		5,640	
	Env Analyst	160	63	10,080						10,080		10,080	
	subtotal												**68,995**
Water/Sed Chem analysis USGS Wisconsin													
4a. Hg/MeHg +DOC analyses 140 samples	$290 ea							40,600		40,600		40,600	
	5% QA external sample									2,030		2,030	
4b. Sample/ Consult	Krabbenhoft /Olson	320				3,000	3,000	22,464		28,464		28,464	
4c. Photodemethylation samples	60 samples x$320ea							19,200		19,200		19,200	
	subtotal												**90,294**
Microbial Methylation USGS Menlo													
5a. Microbial tranformation rates	Marvin Di-Pasquale	295	45	13,275	3,983	2,500	6,000		5,834	31,592	10,204	41,796	
5b. USGS Tech	Tech	980	28	27,440	8,232				8,080	43,752	14,132	57,884	
	subtotal												**99,679**
Fish & benthos sampling													
6. MLML Fish ~44 sam	Fairey+crew 1190/sample collect + 103/per homogenize							56,900		56,900		56,900	
7. MLML Benthos ~44	Fairey+crew 630/sample collect + 103/per homogenize							32,300		32,300		32,300	
	subtotal												**89,200**
USGS BRD													
8a Bioaccumulation · Rails		**Labor Hours**	**Hourly rate**	**Hours x rate**	**Benefits Rate**	**Travel - Field Work**	**Supplies**	**Serv/ Consult.**	**Other Direct Costs***	**Total Direct Costs**	**Indirect Costs (35.65%)**	**Total Cost**	
General Costs for Subtask						2,210	8,000			10,210	3,640	13,850	
USGS	Takekawa	79	38	3,000	1,050					4,050	1,444	5,494	
	Schwarzbach	80	39	3,143	1,100					4,243	1,513	5,756	
	Woo	740	20	15,000	5,250					20,250	7,219	27,469	
	Wainwright-De La Cruz	110	23	2,500	875					3,375	1,203	4,578	
	Technical support	1,389	18	25,000	4,250					29,250	10,428	39,678	
Avocet Assoc	Evens	129	55					7,050		7,050		7,050	
8b Biota Chem analysis													
Total Hg/MeHg 190 samples @ $250ea								47,500		47,500		47,500	
Isotopes - C,N,S 200 samples@$45ea								9,000		9,000		9,000	
	5% QA external samples									2,825		2,825	
	subtotal												**163,200**
GRAND TOTAL												**581,690**	

Form VI: Budget Summary
YEAR 2

Task	Job Titles	Labor Hours	Hourly rate	Hours X rate	Benefits	Travel	Supplies	Serv/ Consult.	Other Direct costs	Total Direct Costs	Indirect Costs	Total Year 1	Task Subtotal
1a.Project Coord/Mgmt	Env Scientist 1	120	103	12,355						12,355		12,355	
1b. Subcontracting	Env Scientist 2	40	135	5,404						5,404		5,404	
	Accountant	40	76	3,045						3,045		3,045	
	Contract Manager	80	82	6,564						6,564		6,564	
	subtotal												**27,369**
2a. Data Management	Env Analyst	120	66	7,862						7,862		7,862	
	System Analyst	40	74	2,964						2,964		2,964	
2b. Data Analysis/Reporting	Env Scientist 1	80	103	8,237						8,237		8,237	
	Env Scientist 2	40	135	5,404						5,404		5,404	
	Env Scientist 3	40	140	5,616						5,616		5,616	
	GIS analyst	40	109	4,368						4,368		4,368	
	Asst. Env Scientist	80	73	5,866						5,866		5,866	
	Env Analyst	80	66	5,242						5,242		5,242	
	subtotal												**45,558**
3a. Field Sampling and Prep						2,000	2,000	3,300		7,300		7,300	
	Env Scientist 1	80	103	8,237						8,237		8,237	
	Env Scientist 2	80	134	10,733						10,733		10,733	
	Env Scientist 3	120	140	16,848						16,848		16,848	
	Asst. Env Scientist	80	73	5,866						5,866		5,866	
	Env Analyst	160	66	10,483						10,483		10,483	
	subtotal												**59,466**
Water/Sed Chem analysis USGS Wisconsin													
4a. Hg/MeHg +DOC analyses 140 samples	$290 ea							40,600		40,600		40,600	
	5% QA external sample									2,030		2,030	
4b. Sample/ Consult	Krabbenhoft /Olson	320				3,000	3,000	23,296		29,296		29,296	
4c. Photodemethylation samples	60 samples x$320ea							19,200		19,200		19,200	
	subtotal												**91,126**
Microbial Methylation USGS Menlo													
5a. Microbial tranformation rates	Marvin Di-Pasquale	295	48	14,176	4,253	2,500	6,000		6,099	33,027	10,668	43,695	
5b. USGS Tech	Tech	980	29	28,863	8,659				8,499	46,020	14,864	60,884	
	subtotal												**104,580**
Fish & benthos sampling													
6. MLML Fish ~44 sam	Fairey+crew 1190/sample collect + 103/per homogenize							56,900		56,900		56,900	
7. MLML Benthos ~44	Fairey+crew 630/sample collect + 103/per homogenize							32,300		32,300		32,300	
	subtotal												**89,200**
USGS BRD			1										
8a Bioaccumulation · Rails		**Labor Hours**	**Hourly Salary**	**Total Salary**	**Benefits**	**Travel - Field Work**	**Supplies**	**Serv/ Consult.**	**Other Direct Costs***	**Total Direct Costs**	**Indirect Costs (35.65%)**	**Total Cost**	
General Costs for Subtask						2,210	8,000			10,210	3,640	13,850	
USGS	Takekawa	79	39	3,120	1,092					4,212	1,502	5,714	
	Schwarzbach	80	41	3,269	1,144					4,413	1,573	5,986	
	Woo	740	21	15,600	5,460					21,060	7,508	28,568	
	Wainwright-De La Cruz	110	24	2,600	910					3,510	1,251	4,761	
	Technical support	1,389	19	26,000	4,420					30,420	10,845	41,265	
Avocet Assoc	Evens	129	57					7,332		7,332		7,332	
8b Biota Chem analysis													
Total Hg/MeHg 190 samples @ $250ea								47,500		47,500		47,500	
Isotopes - C,N,S 200 samples@$45ea								9,000		9,000		9,000	
	5% QA external samples									2,825		2,825	
	subtotal												**166,801**
GRAND TOTAL												**584,100**	

Form VI: Budget Summary
YEAR 3

Task	Job Titles	Labor Hours	Hourly rate	Hours X rate	Benefits	Travel	Supplies	Serv/ Consult.	Other Direct costs	Total Direct Costs	Indirect Costs	Total Year 1	Task Subtotal
1a.Project Coord/Mgmt	Env Scientist 1	120	107	12,830						12,830		12,830	
1b. Subcontracting	Env Scientist 2	40	140	5,612						5,612		5,612	
	Accountant	40	79	3,162						3,162		3,162	
	Contract Manager	80	85	6,817						6,817		6,817	
	subtotal												**28,421**
2a. Data Management	Env Analyst	120	68	8,165						8,165		8,165	
	System Analyst	40	77	3,078						3,078		3,078	
2b. Data Analysis/Reporting	Env Scientist 1	120	107	12,830			2,000			14,830		14,830	
	Env Scientist 2	80	140	11,223						11,223		11,223	
	Env Scientist 3	80	146	11,664						11,664		11,664	
	GIS analyst	80	113	9,072						9,072		9,072	
	Asst. Env Scientist	80	76	6,091						6,091		6,091	
	Env Analyst	80	68	5,443						5,443		5,443	
	subtotal												**69,567**
3a. Field Sampling and Prep													
	Env Scientist 1												
	Env Scientist 2												
	Env Scientist 3												
	Asst. Env Scientist												
	Env Analyst												
	subtotal												**0**
Water/Sed Chem analysis USGS Wisconsin													
4a. Hg/MeHg +DOC analyses 140 samples	$290 ea												
	5% QA external samples											0	
4b. Sample/ Consult	Krabbenhoft /Olson	640				3,000	3,000	36,192		42,192		42,192	
4c. Photodemethylation samples	60 samples x$320ea												
	subtotal												**42,192**
Microbial Methylation USGS Menlo													
5a. Microbial tranformation rates	Marvin Di-Pasquale	295	52	15,218	4,565	2,500			5,047	27,331	8,828	36,159	
5b. USGS Tech	Tech	980	31	30,017	9,005				8,839	47,861	15,459	63,320	
	subtotal												**99,478**
Fish & benthos sampling													
6. MLML Fish ~44 sam	Fairey+crew 1190/sample collect + 103/per homogenize							56,900		56,900		56,900	
7. MLML Benthos ~44	Fairey+crew 630/sample collect + 103/per homogenize							32,300		32,300		32,300	
	subtotal												**89,200**
USGS BRD			1										
8a Bioaccumulation · Rails		**Labor Hours**	**Hourly Salary**	**Total Salary**	**Benefits Rate**	**Travel - Field Work**	**Supplies**	**Serv/ Consult.**	**Other Direct Costs***	**Total Direct Costs**	**Indirect Costs (35.65%)**	**Total Cost**	
General Costs for Subtask						2,210	5,000			7,210	2,570	9,780	
USGS	Takekawa	158	41	6,479	2,268					8,747	3,118	11,866	
	Schwarzbach	168	42	7,128	2,495					9,623	3,431	13,054	
	Woo	1,481	22	32,400	11,340					43,740	15,593	59,333	
	Wainwright-De La Cruz	221	24	5,400	1,890					7,290	2,599	9,889	
	Technical support	1,389	19	27,000	4,590					31,590	11,262	42,852	
Avocet Assoc	Evens	256	59					15,147		15,147		15,147	
8b Biota Chem analysis													
Total Hg/MeHg 190 samples @ $250ea Isotopes - C,N,S 200 samples@$45ea													
	5% QA external samples												
	subtotal												**161,921**
GRAND TOTAL												**490,779**	

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.

Task 1 (under project management)
Task 2a Systems Analyst 40 hrs/yr Environmental Analyst – 120 hrs/yr
Task 2b Environmental Scientists 1&2&3- 40 to 80 hrs/yr; Assistant Env. Scientist 80 hrs/yr; GIS Analyst 40 hrs/yr; Env Analyst 80 hrs/yr
Task 3 Env. Scientist 1&2&3 80-120 hrs/yr; Assistant Env. Scientist 80 hrs/yr; Env. Analysts 1&2 160 hrs/yr Hours and Rates of collaborating PIs provided under their respective tasks on budget summary.

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

Rates for the above individuals given for the first year. Rates in subsequent years projected to rise ~4% per year for cost of living and merit raises.

Systems Analyst - $24/hr Environmental Analysts 1&2 - $21/hr Environmental Scientists 1&2&3 - $33, $43, $45/hr Asst. Env. Scientist - $24/hr, GIS analyst $35/hr

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

Benefit rate is 18% of salary for all individuals above. Rates for Co-PIs differ and are in budget summary and given under services/consulting.

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

Travel costs listed all for local travel

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

Supply costs for field sampling supplies purchase/rental, ~$9000/yr1, ~$2000/yr2, Printing costs ~$2000/yr3.

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 3 - $1500yr grainsize measurements on 36 sediment samples $1800/yr analysis of ~45 fish tissue samples for stable isotopes

Co-PIs have individual benefits and overhead rates

Tasks 4a-c USGS Wisconsin Direct Labor

a. Hours . Task 4b David Krabbenhoft- 160 hrs/yr (yrs 1&3) ~120 hrs/yr2 Mark Olson- 160 hrs/yr (yrs 1&3) ~120 hrs/yr2
b. Salary David Krabbenhoft $39/hr in yr 1 Mark Olson- $24/hr in year 1 Cost of living and merit increases are estimated at 7% for yr 2 & 3.
c. Benefits Benefits are estimated at 30% of base salary costs and included in Service/consulting costs.
d. Travel Travel costs includes travel for 2 sampling trips in year 1 for Krabbenhoft and Olson ($2000). Year 2 and 3 include travel for 1 sampling trip (~$1000/year). Additional $400 are included for Dr. Krabbenhoft to attend project principal investigator meetings and/or professional scientific meetings related to this work.
e. Supplies & Expendables Primary costs are for field supplies ($2000/yr). Office and computing costs are included in USFWS overhead.
f. Services or Consultants Direct labor hours and benefits and USGS overhead rate (51%) are included in this category for task 4b. Task 4a, analysis of Hg/MeHg/DOC is calculated at $290 per sample for 140 samples per year. Task 4c, analysis of Hg/MeHg isotopes at $320 per sample is calculated for 60 samples per year
g. Equipment There are no permanent equipment costs for these project tasks.
h. Project Management Project management for USGS tasks included in direct labor estimates for Dr. Krabbenhoft under Task 4b.
i. Other Direct Costs No other direct costs are requested.
j. Indirect Costs The USGS overhead rate (51.36% of total direct costs) applied to state and federal projects includes costs associated with rent and maintenance for USGS facilities, security, phones, furniture, and general office staff (secretaries and administrators). Overhead is already contained within items in the direct cost categories for USGS Wisconsin.

Task 5- USGS Menlo Park Direct

a. Labor Hours Task 5 (MMD) This project is estimated to command a 15% annual (295 hrs) effort on the part of Dr. Marvin-DiPasquale for each funding year. It will also require an estimated 50% annual effort (980 hrs) each year, on the part of one technician to process all samples and to assist in data analysis.
b. Salary Task 5 (MMD) The current full annual salary for Dr. Marvin-DiPasquale is $87,640/yr, and is $53,770/yr for a GS-11 technician. The compensation costs for this project are calculated from these annual salaries and the percent annual effort anticipated dedicated to this project per individual, as noted above. Cost of living increases are estimated at 4% for the second and third year.
c. Benefits Task 5 (MMD) All benefits are calculated at 30% of base salary costs.
d. Travel Task 5 (MMD) Travel for costs are requested for Dr. Marvin-DiPasquale and two technicians, to conduct two scheduled sampling events each year ($2000/yr). This includes food, lodging (4-5 days per sampling events), and gas/maintenance of two project vehicles (Suburban and radioisotope mobile laboratory truck). Additional funds ($1,000/year in YR2) are included for Dr. Marvin-DiPasqule to attend project principal investigator meetings and at least 1

non-local professional scientific meetings related to this work. These costs include airfare, car rental, lodging and per diem.

e. Supplies & Expendables . Task 5 (MMD) Primary costs are for laboratory and field supplies ($6000/yr), and include: compressed gases, sampling equipment, chemicals, and radioisotopes. Office and computing costs will be paid for by the USGS (cost sharing).
f. Services or Consultants Task 5 (MMD) There are no outside service contracts associated with this task.
g. Equipment Task 5 (MMD) There are no permanent equipment costs exceeding $5,000.
h. Project Management Task 5 (MMD) Approximately 50% of Dr. Marvin-DiPasquales time on this project will be dedicated to project management which includes: overseeing sample analysis by laboratory technicians (i.e. inspection of work in progress), validation of costs, reports preparation, giving presentations, response to project specific questions, etc The funding for this project management is included in his requested salary
i. Other Direct Costs Task 5 (MMD) USGS Menlo applies a 22.65% facilities charge on all direct costs.
j. Indirect Costs Tasks 1 (MMD) The USGS overhead rate (32.3% of total direct costs) applied to state and federal projects includes costs associated security, phones, furniture, and general office staff (secretaries and administrators). Budget Justification-

MLML fish and benthos sampling (Tasks 6&7)

a. Direct Labor Hours . Task 6 Estimated 3 days in field per site for crew of 3 x 22 sites/yr ~530 hrs/yr for Rusty Fairey + 2 assistants Task 7 Estimated 1 day in field per site for crew of 3 x 22 sites/yr
b. Salary Rusty Fairey $31/hr, Assistant 1 $16/hr, Assistant 2 $12/hr in year 1 Cost of living and merit increases are estimated at 5% for the second and third year.
c. Benefits Benefits are estimated at 25.3% of base salary costs, included in the salary.
d. Travel Travel is local for sampling, ~88 days in the field, overhead included total is $23950 yr 1
e. Supplies & Expendables Field supplies + equipment + overhead total ~$11350 in year 1. Office and computing costs are included in MLML overhead.
f. Services or Consultants All expenses including overhead collapsed into this category as per sample costs: Task 6 (fish sampling + homogenization) = ($1190 + $103) /sample x 44 samples/yr Task 7 (benthos sampling + homogenization) = ($631 + $103) /sample x 44 samples/yr Estimated hours given under direct labor.
g. Equipment There are no permanent equipment costs over $5000 for these project tasks.
h. Project Management Project management tasks included in labor described above.
i. Other Direct Costs No other direct costs are requested
j. Indirect Costs The MLML overhead rate (26% of total direct costs) applied to state and federal projects includes costs associated with rent and maintenance for

MLML facilities, security, phones, furniture, and general office staff (secretaries and administrators).

USGS BRD (Task 8a,b)

a. Direct Labor Hours Task 8a Staff scientists-total 1010 hrs/yr (yrs 1&2), ~2030 hrs/yr3, technician 1390 hrs all years
b. Salary Staff scientists- $22, 24, 41, 42/hr Cost of living and merit increases are estimated at 4% for the second and third year.
c. Benefits Benefits at ~35% of base salary costs for scientists, ~17% for technician
d. Travel Travel is local for sampling
e. Supplies & Expendables Primary costs are for field supplies ($1000/yr) + overhead. Office and computing costs are included in USFWS overhead.
f. Services or Consultants- costs are for MeHg/Hg (~$250 ea) and stable isotope (~$45 ea) analyses of 190-200 prey items and bird samples annually.Equipment There are no permanent equipment costs for these project tasks. Jules Evens (Avocet Associates) is serving as a consultant directly under SFEI.
g. Project Management Project management for USFWS tasks included in direct labor described above
h. Other Direct Costs No other direct costs are requested.
i. Indirect Costs The USFWS overhead rate (29% of total direct costs) applied to state and federal projects includes costs associated with rent and maintenance for USFWS facilities, security, phones, furniture, and general office staff (secretaries and administrators).

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.

No items above $5000 per unit

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.

Listed under Task 1 on the budget sheet. 120 hrs/yr Env. Scientist 1, 40 hrs/yr Env Sci 2, Accountant 40 hrs/yr, Contract manager 30 hrs/yr. Tasks are associated with general project management including contract drafting, tracking work progress, billing. Reporting/presentation are included in Task 2, data management/analysis/reporting.

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

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.

Hourly billing rates are provided, which include costs of salary, benefits, rent, communications, office equipment, office supplies, administrative staff, administrative time, holiday, vacation, and sick time. The budget forms are provided in 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. Direct salary rates for individual staff are provided previously in this section. The billing rate is similar to the net results of benefits, facility charge, and indirect expenses applied by USGS to all salary and direct expenses. Itemization in this manner will be provided on request.

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

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A. PROJECT DESCRIPTION

1. Problem Statement

Efforts to restore wetland ecosystems, including projects supported by CalFed, are being proposed or underway in various locales, among them areas in San Pablo Bay and Petaluma River. Although wetland restoration provides ecological benefit, in some cases restoration of mercury-contaminated areas may negatively impact wildlife or human health unless steps are taken to minimize such risks. Among the concerns are impacts on vertebrates that are linked closely with tidal marsh habitats which may accumulate potentially harmful concentrations of mercury, including the federal and state endangered California clapper rail, the state threatened California black rail, and the Virginia rail. Fishes that forage in or around wetland habitats may also accumulate mercury, impacting other wildlife and humans that consume those fish. Relatively little effort to date has been devoted to investigating these impacts in tidal wetlands, which this proposal aims to address. The goals of this study are to improve understanding of the following:

- Spatial and temporal variation of mercury (Hg) and methylmercury (MeHg) in North San Francisco Bay tidal wetlands
- Environmental factors influencing the net methylation of Hg in these areas
- MeHg bioaccumulation and impacts in rails (black, Virginia, and clapper) and other species at different trophic levels in these environments
- Contribution of MeHg in tidal wetlands to the rest of the San Francisco estuary

Improved understanding of these factors will allow better management of wetland restoration to minimize negative impacts on wildlife and human health.

MeHg, primarily formed by bacteria in anaerobic environments like wetland sediments, is more toxic with greater potential for bioaccumulation than elemental and other inorganic forms of Hg commonly released by human activity. Previous studies have found correlations between MeHg and percentage of wetland coverage in watersheds (*1-3*). Hg present in soils and vegetation is released to aquatic environments after flooding and transformed into MeHg, with resulting increases in fish tissue concentrations (*4-6*). MeHg is particularly high in newly flooded wetlands, due to large quantities of organic carbon available for bacteria to generate anaerobic conditions (*6*).

There is a substantial and growing body of work on Hg geochemistry and bioaccumulation, but much remains to be elucidated about Hg in local wetlands. A number of environmental parameters such as total Hg (*7, 8*), salinity (*9, 10*), sulfate (*8, 11-13*), sulfide (*14*), temperature (*15*), pH (*16-18*), and dissolved or total organic carbon (*9, 17, 19*) have been shown to influence Hg bioaccumulation and MeHg production or degradation. These factors may interact in antagonistic or synergistic manners and can vary in estuarine systems spatially and on seasonal and daily time scales.

This study aims to examine the environmental factors controlling Hg and MeHg distribution in sediments, water and selected biota of tidal marshes in North San Francisco Bay. Sampling will occur from winter to midsummer for three years to evaluate influences of seasonal and interannual variations on Hg geochemistry and bioaccumulation. We expect some relationships reported previously in other estuarine ecosystems will be similar for the local environment. Differences from previous work will also be instructive; by evaluating these similarities and differences, we can refine our conceptual understanding of Hg processes for the local estuarine environment.

CalFed can apply this knowledge in deciding where and how to proceed with tidal wetland restoration projects. For example, if net MeHg is elevated within a particular range of sulfate concentrations, restoration projects might be better pursued in areas with sulfate concentrations outside this range. Similarly, if wet-season flows deposit sediments with higher Hg than in the dry season, decisions for timing the breaching of dikes could be altered. If MeHg is associated with certain physiographic features within wetlands, projects may be designed to minimize these features. Potential Hg methylation is only one of many factors that should be considered; timing and location of wetland restorations should also be guided by the life cycles and other requirements of particularly desired biota (e.g. species endangered or with commercial and recreational value). For restorations that proceed, additional studies can then be conducted to further refine our understanding of Hg transformation and bioaccumulation in an iterative and adaptive management process.

2. Justification

Research on Hg and MeHg processes is necessary given the temporal and spatial scope of ongoing and proposed restoration projects; there is great uncertainty in projecting future impacts of wetland restoration projects given large differences in physical, hydrological, biological, and chemical characteristics between older and newer marshes. Attempting course corrections by manipulating water or sediment loads after a project has significantly progressed years or decades later will be difficult if not impossible. By examining characteristics of similar wetlands at further stages of development, we can better anticipate the likely mid- and long-term progression and Hg impacts of restoration projects.

Although estuarine environments often produce less MeHg than freshwater environments, Hg concentrations exceeding thresholds for toxic effects are found in fail-to-hatch clapper rail eggs in this region. San Francisco Bay fish tissue Hg concentrations are also high enough to warrant a human consumption advisory. Thus, Hg processes should be studied locally to better understand their role in these negative impacts. Information on the primary influences on MeHg production and accumulation in regional food webs will be needed in decision-making processes for wetland restoration. By providing data to refine our understanding of existing local wetlands, better predictions for the outcomes of restoration projects can be made and negative impacts avoided. Evaluating relationships between Hg and MeHg in wetlands and resident biota can illuminate likely outcomes from alternative management actions. Understanding Hg transformations and trophic transfers within the local food web will allow better evaluation of restoration projects such as in choosing appropriate sampling strategies, which can then be used in choosing the next iteration of management actions.

a. Conceptual model

Problems with Hg contamination arise when a number of factors occur:

- Hg is elevated above natural concentrations in the ecosystem
- Bacterial transformations convert inorganic Hg into MeHg
- MeHg bioaccumulates in the wetland food web at harmful concentrations
- MeHg is exported to other ecosystems where it bioaccumulates

We hypothesize that the combination of these factors lead to problems with Hg bioaccumulation in local biota. Our current conceptual understanding of environmental Hg processes and the information needed to test the validity of this model are presented below for the highly interrelated issues of environmental Hg distribution, biogeochemical transformation, and bioaccumulation. Physiography of individual wetlands and features within them will change many of these factors simultaneously.

1) Wetland physiography

Older tidal wetlands share a common physiographic template and set of geomorphic features and processes, and spatial patterns in that template and seasonal variation in environmental conditions will cause differences in MeHg production and degradation within tidal marshes. Preliminary data from USFWS studies support this hypothesis; significant differences between surface sediment MeHg concentrations of first and third order channels were found. Physiographic features also impact food web structure, but the impacts of these on Hg bioaccumulation are difficult to predict. Understanding the processes that causing these patterns will help identify the most highly impacted species, compare within tidal wetlands using stratified sampling, and compare regionally among wetlands by finding appropriate monitoring strata.

Less established marshes will not share the same physiography, but features within those wetlands will also show spatial patterns, allowing stratified sampling. By examining marshes of different ages in a salinity regime, differences in Hg processes arising from geomorphic features may become apparent. The ability to compare along chemical and development gradients will allow CalFed to select locations and methods for wetland restoration that minimize potential Hg accumulation hazards and to project likely long-term changes in site characteristics as wetland projects mature.

Possible impacts of wetland features on the other factors impacting mercury processes will be addressed in the discussions of those factors below.

2) Mercury distribution

These hypotheses on Hg and MeHg distribution in tidal wetlands will be tested:

- Hg concentrations are elevated above natural background concentrations
- Differences exist in total Hg and MeHg within and among wetlands
- Total Hg and MeHg concentrations correlate spatially and temporally

Wetland restoration cannot provide habitat less contaminated with Hg and MeHg than conditions prior to human influence. Background concentrations may not be achievable through local management, as anthropogenic atmospheric Hg has impacted sites distant from industrial activity (*20*). Locally, large loads of Hg-laden fine sediments from Gold Rush mining (ca. 1850-1880) and more recent deposits (ca. 1950) from mechanized Hg mining and other industrial activities (*21*) have collected in the San Francisco Estuary and may impact regional tidal wetlands. However, recent studies in the Everglades using wetland enclosures and Hg stable isotope tracers indicate that newly applied Hg is more apt to be methylated and bioaccumulated (*22*), so older deposits may not be as important

as current sources of inorganic Hg. This study will compare measured Hg and MeHg to wetlands to those in other regions and concentrations expected from local geology.

This study will examine if significant differences in Hg and MeHg distribution exist for the sites within and among marshes. Hg and MeHg concentrations in tidal wetlands and their link to other ecosystem factors such as hydrology and geochemistry are needed to understand possible risks to the ecosystem. Uncertainty of how total Hg correlates with negative impact on biota is reduced by also measuring MeHg. Concurrent measurements of total Hg, MeHg and other environmental parameters in water, biota, and sediment will inform us about the relationships among these factors, to help assess the risk posed by Hg in wetlands and determine if possible management alternatives.

Some studies have found significant correlations between total Hg and MeHg concentrations in sediments (*8*) and water (*23*), but CalFed-funded studies in the Delta have not yet indicated significant influence of total Hg on net MeHg concentrations (*24*). Interpretation may thus far be confounded by other factors at the sampled sites. Other researchers have suggested a threshold (ca. 5,000 ng/g dry wt.) above which additional Hg(II) does not increase MeHg production (*25, 26*). To make informed decisions on wetland restoration, managers need to know if significant differences exist in total Hg of North Bay tidal wetlands, and whether these differences correspond to differences in MeHg production and accumulation in biota.

3) Mercury transformations

The lack of correlation between total Hg and MeHg in some cases reflects the influence of many environmental parameters on Hg methylation. These are documented in the literature but show divergent results over different ranges of these parameters. We wish to test the following hypotheses regarding Hg transformations with this study:

- Multiple biogeochemical factors mediate MeHg production and degradation among and within wetlands
- Differences among wetland features influence net MeHg production
- Geomorphology and salinity regime mediate the degree of MeHg production
- Net MeHg production varies seasonally and interannually
- MeHg degradation is important in net MeHg production

In addition to Hg and MeHg measurements, we will examine the following environmental parameters to evaluate their influences on net MeHg production: salinity, pH, sulfate, dissolved organic carbon, sediment organic carbon and sulfur, acid volatile sulfide, redox potential, temperature, and wetland geomorphology. Examining the specific influence of these factors on MeHg in the local ecosystem can reduce uncertainty arising from conflicting results in previous research for other ecosystems.

A number of parameters generally co-vary among wetlands and within wetland features. Some factors may affect inorganic Hg bioavailability and MeHg production and degradation additively or synergistically, whereas others will act antagonistically. Hg geochemistry is complex given interactions between these factors, and field studies are needed to further our understanding of Hg processes in the local environment.

Even given this likely complexity, a number of characteristics may emerge. We expect that longer inter-tidal sediment exposure periods and more “freshwater” signatures with moderate water column sulfate (*8, 11-13*) concentrations will promote higher rates of net MeHg production in wetlands. Seasonal variability will likely be driven by differences in freshwater influence and effects of temperature and solar radiation on

methylation and demethylation processes. Although three years of sampling provides little statistical power in evaluating interannual variability within any season, it will provide at least first order estimates of the influence of these factors. Furthermore, spatial differences in net MeHg within and among wetlands with similar degrees of marine influence will be influenced by hydrological and biological differences of morphological features. These factors are discussed in more detail below.

Sulfur: Anoxic sediments are the primary zones of mercury methylation by sulfate reducing bacteria (SRB) (*27*), although SRB can methylate Hg while fermenting as well. Depending on the sulfate concentration, it may either increase or decrease net MeHg (*14*). Increasing sulfate (SO_4^{2-}), up to approximately 1-3 mM, typically stimulates the activity of SRB in freshwater sediments (*28*). A corresponding increase in SRB mediated Hg-methylation is thus often observed with increasing SO_4^{2-} (*11, 29*). However, the activities of SRB also reduce SO_4^{2-} to sulfide (S^{2-}). MeHg production rates are highest under low S^{2-} (ca. 1-10 μM), while higher S^{2-} concentrations begin to inhibit the Hg-methylation process (*14*). Since many factors such as O_2 mediated reoxidation of S^{2-} to SO_4^{2-} and metal-sulfide mineral formation (e.g. FeS, FeS_2, MnS, etc.) influence dissolved S^{2-} concentrations in sediments, localized physical and geochemical processes (e.g. bioturbation, microbial Fe- and Mn-reduction, plant-mediated O_2 transport to the rhizosphere) dictate the zone of maximum benthic MeHg production in both time and space. The spatial and temporal coverage of this study will result in a range of water and sediment sulfur concentrations and speciation.

Transformation rates: Various biotic and abiotic processes degrade MeHg. The competition between production and degradation ultimately dictates net MeHg production (*30, 31*), but few ecosystem-level investigations have measured both processes (*32*). MeHg degradation in sediments may proceed by *mer*-operon mediated microbial detoxification (*33, 34*), microbial oxidative demethylation (*35*), and abiotic reductive demethylation linked to reactions with sulfide (*36*). Photodegradation of methylmercury can be a major sink of MeHg in some ecosystems (*37, 38*), and as a result water clarity or solar intensity (particularly UV light) can have a strong influence on observed MeHg levels in the waters. Understanding the relative importance of these Hg-transformations and the environmental factors controlling them is critical to assessing the fate and transport of Hg in a given ecosystem, and in the development of cost-effective planning or remediation strategies. Measurements of biotic and abiotic methylation and demethylation rates in this study will improve our understanding of the role of these processes in producing observed MeHg distributions in the environment.

Geomorphology: USFWS data collected in older North SF Bay tidal marshes suggest that differences in channel order and wetland morphology result in differences in sediment MeHg concentration, production, and/or cycling (*39*) that conform to some of our expectations of MeHg geochemistry. Because of smaller tidal excursions and lower flow rates associated with low-order channels, MeHg production is likely to be higher and occur nearer the surface than in higher order channels. The increased organic load found in low-order channels may also increase anaerobic bacterial activity and thus Hg methylation. Lower flow regimes in low-order channels may also disturb the sediment surface less, allowing the oxic/anoxic interface to develop nearer the surface. This may impact biota at the sediment surface, as they will reside near or in zones of maximum MeHg production and accumulation. Smaller channels comprise a large fraction of total

surface area within wetlands, so they may also contribute a large fraction of a wetland's MeHg output to adjacent ecosystems. Lower order channels may also have higher temperatures, as less cold and aerated water finds its way up the farther reaches of a marsh on each tidal cycle. Higher temperatures may increase net methylation (*15, 40*), even if demethylation rates also increase (*31*). Physiographic differentiation in younger marshes is expected to be less distinct than in older systems, and thus net MeHg production within a less developed marsh is likely to be more uniform throughout. Site selection in this study therefore will includes wetlands of different ages within a zone of similar salinity conditions to test this.

Marine influence: With increasing marine influence in an estuary, salinity, pH, and sulfate all generally increase. Salinity and sulfate influence Hg methylation non-linearly over the range of estuarine concentrations. At low and high chloride, bacterial Hg uptake and methylation is reduced relative to rates at intermediate salinity (*9*), and this effect is also seen on phytoplankton Hg uptake (*10*). Bacterial methylation rises as sulfate increases to intermediate levels, but decreases as sulfate rises further. The ratio of MeHg to total Hg is relatively low in some estuaries (*8*), possibly due to higher marine sulfide concentrations. Another mechanism potentially contributing to low estuarine MeHg production is the increase in oxidative demethylation by SRB with higher sulfate concentrations in estuaries (*13*). In freshwater systems, Hg methylation rates increase with decreasing pH in the epilimnion and surface sediment of lakes (*18*). Others have found increased MeHg concentrations correlate well with decreased pH in lakes for fish and zooplankton, respectively (*16, 17*). Increased pH with increasing marine influence might therefore be expected to decrease Hg methylation and net accumulation.

Statistical methods such as multiple regression and principal components analysis can be used to evaluate the primary influences from among the many environmental factors. For sulfate, chloride, and other parameters with non-linear effects on MeHg, transformations to models more closely approximating known chemical and biological processes (uncharged chloride species, relative methylation to demethylation rates at various sulfate levels) may be needed for proper evaluation of their influence.

4) Mercury bioaccumulation

Hg bioaccumulation will be evaluated to determine whether patterns seen in net MeHg production in sediment or water translate into patterns in food web contamination. Hypotheses of Hg bioaccumulation to be tested in this study are as follows:

- Bioaccumulated Hg correlates with trophic level of an organism
- Hg in biota correlates with MeHg concentration in water and/or sediment
- Hg concentrations for sessile benthic organisms therefore exhibit spatial variations similar to those of water and/or sediment at that site
- Hg and MeHg concentrations and reproductive success in rails reflect prey items from specific microhabitats in small home ranges where they forage.

Trophic position is one major factor influencing tissue Hg concentrations, increasing with each step in the food web. Organisms from multiple trophic levels will be sampled to assess whether spatial and temporal patterns propagate through the food web. Particular attention will be given to potential food web transfer of MeHg to rails.

Past work by USFWS has found Hg concentrations in fail-to-hatch clapper rail eggs exceeding toxic effects thresholds. Developing embryos are the most sensitive life stage for Hg toxicity. Observed Hg concentrations may contribute to the low productivity

observed for San Francisco Bay rails. Because of the fidelity of individual rails to a particular marsh and even specific territories within that marsh for feeding, they may reflect the spatial variability in Hg concentrations found within and between marshes.

Benthic invertebrates also do not travel between marshes, and they seldom move even within a marsh. They will therefore reflect spatial differences in MeHg among marshes and possibly among locations within marshes. The short life spans of some species may also result in observable seasonal differences in tissue MeHg concentrations.

Tidal wetland fish species are generally more mobile than invertebrates. Fishes such as silversides and juvenile striped bass move easily among channels and therefore may only reflect differences among marshes and not differences within any marsh. Sampling of juvenile striped bass in 1999 found 2-fold higher Hg in a marsh site relative to an open Bay site, suggesting marshes may be sites of enhanced Hg accumulation. Territorial fishes such as gobies and sculpin that feed at the sediment move less and thus may reflect the spatial variations within a marsh. Resident territorial fish can be analyzed to test the relationship between wetland Hg/MeHg and concentrations in tissue. Fish species that only reside part-time in wetlands can be used to evaluate the influence of wetlands on their Hg bioaccumulation and impacts on food webs outside of the wetlands where larger fish, pescivorous wildlife, and humans may ingest them.

5) MeHg export

Although mobile fish may transport of MeHg localized in wetland ecosystems to the wider San Francisco Estuary food webs, hydrological flows from wetlands may also export MeHg dissolved in water or carried in fine sediments, phytoplankton, and zooplankton. The hypothesis that regional wetlands are net suppliers of MeHg to the rest of the ecosystem can be tested and estimated using gradients in MeHg distribution and calculations of hydrological flows. This is information needed by CalFed to evaluate the possible risk of increased MeHg export from expanded regional wetland coverage, weighed against improved wildlife habitat and other benefits.

3. Approach

a. Site selection

Variation in environmental characteristics influencing Hg/MeHg transformation rates and concentrations will be examined by sampling five wetlands (Figure 1) from winter through summer to include high and low freshwater flow periods. Wetlands were selected to explore correlations between MeHg availability and marsh age and salinity regime. Wetlands along the Petaluma River gradient were chosen because it lacks any known local source of Hg, involves tidal marshes throughout its length, and many of these marshes have supporting scientific information.

To examine the MeHg-marsh salinity relationship, three marshes of middle age (50-100 years) were selected along the salinity gradient of the Petaluma River: one 8 miles upstream from San Pablo Bay, one mid-gradient 5 miles upstream, and one at the river mouth. Marshes of this age were chosen to represent the physiography and community structure commonly accepted as the endpoints of restoration efforts.

To examine the MeHg-marsh age relationship, two additional marshes at the mouth of the Petaluma River of ages 10 years and about 500 years will be compared with the river mouth location of 50-100 years that is also part of the salinity gradient. These three marshes of varying age are subject to the same salinity and tidal regime. These sites will

focus on marsh development to examine possible changes over time of restoration on MeHg availability. All three sites are conveniently located near each other.

Prior to sampling, we will install stage height recorders at each marsh to calculate the high tide datum and measure elevation at the potential sample sites relative to the that datum, allowing us to better determine the frequency, height, and duration of inundation that might be important to MeHg production or degradation. This will allow us to better select, characterize, and stratify sites within each marsh.

b. General sampling approach

Within marshes, sediment samples will be taken from the banks of channels, where MeHg is most likely available to channel fauna, including steelhead, striped bass, and rails, which are fairly abundant in some of these marshes. Sediments and water will be sampled from 2nd and 4th order channels where possible. For younger, less-developed marshes, samples will be taken from channels and the interface between the tidal flat and vegetated plain. When practical, water samples will be collected from larger channels on both flood and ebb tides. This temporal and spatial sampling distribution should lead to a wide range of the key environmental parameters likely important in mediating the Hg-cycle in natural systems. Estimates of microbial and photochemical MeHg production and degradation rates will also be measured for those samples. The most abundant biota from lower taxa will be sampled from sites during three seasons. Higher trophic level biota will be sampled once annually. From this suite of measurements we will statistically assess which variables are most important in controlling spatial and temporal differences in Hg cycling for these wetlands.

c. Mercury and methylmercury distribution

This study will test our hypotheses that Hg and MeHg concentrations vary widely, but systematically, within and among tidal wetlands. The null hypothesis is that Hg and MeHg concentrations do not vary significantly over time and in space. To examine spatial variability at older marshes, one 2nd order and one 4th order channel site will be sampled in each marsh during each sampling season. Samples will be taken from surface sediments (0-2 cm) during ebb tide at edges of channels, and 8-10 subsamples composited for each site to reduce the number and expense of sample analyses for contaminants. Higher trophic level biota will be spatial and temporal integrators of contamination, so capturing small (meter) scale variations in Hg and MeHg concentration through analyses of separate samples within a site is unnecessary. Newer marsh with little or no developed channel hierarchy will also be sampled at two strata: edges of small channels, and the interface of the tidal flat and vegetated plain. At one marsh each season, composite samples from two additional sites of a single stratum (e.g. 2nd or 4th order channel) will be collected.

Sediment samples will be analyzed for Hg (CVAFS, EPA 1631), MeHg (EPA Method 1630 modified (*41*)), TOC (loss on ignition), grain-size (wet and dry sieving), and acid volatile sulfur (*42*). Temperature, pore-water redox potential, sulfide, electrical conductivity, and pH will be measured by probe in situ at the sediment surface. Pore-water sulfate and chloride will be measured in the lab via ion chromatography. Samples will be kept on ice in the field and shipped frozen to the analytical labs (USGS Wisconsin for Hg/MeHg, USGS Menlo Park for sediment ancillary measurements).

At least one water sample will be collected for Hg and MeHg analysis using clean techniques (EPA 1669) at each site. In larger channels (>2m width, 0.3m depth), depth

and cross sectional integrated samples will be collected as needed to obtain a suitably representative water sample. Separate water samples will be collected at each site for suspended solids (APHA Standard Methods) and other ancillary measurements. Duplicate samples will also be collected immediately at two sites per season to evaluate short-term variability in collection and ambient conditions. When possible, water samples at larger channel sites will be collected on both flood and ebb tides in a day. Temporal coverage may not be sufficient for an accurate "mass budget" of MeHg in wetlands, but differences in ebb and flood concentrations, distribution among and within the wetlands, with estimates of hydrological flows, degradation, and other loss pathways, can provide rough calculations of net MeHg transport. This information is useful for environmental managers to consider potential risk posed by MeHg transport beyond the boundaries of particular wetlands and to provide the foundation for developing more accurate regional estimates as they are needed.

Water samples for Hg/MeHg analyses will be preserved with 1% HCl. Water samples will be analyzed for MeHg, total Hg, sulfate, chloride, and DOC. Water column electrical conductivity, pH, redox potential, and optical density of the water will be measured in the field. Water and sediment sampling will be performed by SFEI staff, with Drs. Krabbenhoft's and Marvin-DiPasquale's participation on both sampling trips for the first year to provide guidance. Total Hg/MeHg and DOC in water samples will be analyzed by Dr. Krabbenhoft's lab at USGS (Wisconsin). Ancillary measurements in water samples will be made at USGS Menlo Park or subcontracted to other labs as needed subject to the collaborators' approval.

d. Mercury transformations

Microbial Hg methylation and demethylation rates will be assessed at all the described locations in winter and late summer. Potential Hg methylation rates will be measured in homogenized surface sediment (0-2 cm) using a $^{203}HgCl_2$ amendment radiotracer technique (*43*). Sediment will be collected using trace-metal clean procedures, and sub-sampled in the lab anaerobically in a N_2-flushed glove bag. Short-term ($\leq$ 6 hour) incubations will be carried out in sealed serum bottles at in-situ temperatures ($\pm$ 1 ^{0}C). Incubations will be arrested by flash freezing. The end-product $Me^{203}Hg$ will then be organically extracted and quantified by gamma counting. Rate constants (k_{meth}) derived from these radiotracer assays will be multiplied by the in-situ pool size of "reactive" Hg(II) to estimate in situ rates of Hg-methylation. This "reactive" Hg(II) pool will be operationally defined as the amount of Hg(II) converted to gaseous Hg^0 by tin-chloride in non-acid-digested whole sediment.

Microbial MeHg degradation in 0-2 cm surface sediment will be assessed for all sites. Incubations will be conducted at the same incubation time and temperature conditions as for Hg methylation. The radiotracer ^{14}C-MeHg amendment method will be used, with quantification of end-product gases ($^{14}CH_4$ and $^{14}CO_2$) by the CH_4-comustion/CO_2-trapping method (*44*). Rate constants (k_{deg}) derived from these radiotracer assays will be multiplied by the in-situ pool size of MeHg in bulk sediment to estimate in situ rates of MeHg degradation. This approach provides a cursory measure of the MeHg reductive or oxidative degradation pathways in a particular system (*45*). Such differences in pathway may have important implications on the relative production of dissolved gaseous Hg^0 or Hg(II) as potential end products of MeHg degradation, and subsequently on the residence time of Hg in the sediment.

Photochemical MeHg degradation will be measured by in situ incubation of site water spiked with MeHg synthesized from stable isotopes of mercury (e.g., $Me^{199}Hg$). Incubating sample bottles with the amended isotope spikes will be suspended at water surface (*37*). Replicate samples will be pulled from the water column at specific time intervals to estimate photo-demethylation rates and included in the accounting for MeHg and Hg transformation rates.

Ancillary measurements in the lab for sediment will include microbial sulfate reduction rate (via ^{35}S radiotracer) (*46*), whole sediment acid-volatile reduced sulfur (*47*), organic content (loss on ignition and/or CHN analyzer), and pore-water sulfate and chloride (via ion chromatography). Measurements taken in the field will include temperature, electrical conductivity, redox potential, and pH (via probes), and sulfide (via ion specific probe). This information will us help elucidate what controls observed differences in Hg-transformations in the various benthic samples.

Hg methylation and demethylation incubations and ancillary measurements will be made by Dr. Marvin-DiPasquale's lab at USGS (Menlo Park). Photo-demethylation samples will be analyzed by Dr. Krabbenhoft's lab at USGS (Wisconsin).

e. Bioaccumulation

Spatial and temporal variations in distribution of Hg and MeHg may result in observable effects on Hg in biota. Hypothesized spatial and temporal patterns within marshes will be evaluated with non-migratory, lower trophic level species, including bivalves, amphipods, crayfish, and other benthic invertebrates. These organisms are important components of the diet for rails and other marsh inhabitants. Benthic species will be evaluated as potential indicators of variation with channel order and season. Within each marsh, composite samples of the lower taxa will be collected at each sampling site. Variation in Hg speciation between marshes and food web bioaccumulation will also be evaluated in fish and rails.

Given similarities in habitat use with clapper rails (*48*) and few clapper rails in study area, black rail will be used as a model for studies of Hg bioaccumulation. Only fail-to-hatch eggs of the threatened black rail may be collected, but some methods (e.g., radio-marking) more restricted for clapper rails may be used. Clapper and black rails prefer saline and brackish wetlands (*49, 50*), while breeding Virginia rails are generally associated with fresh waters (*51*), so these species will be representative of the range of wetlands in this study.

Telemetry methods allow individual birds to be followed in dense cover. This tool coupled with visual observation will be used for determining site fidelity and core foraging areas for individual birds (*52*). We will capture (black and Virginia) rails with double-door box traps and weigh, measure, collect blood (<0.5 ml) and body feather (6) samples, radio-mark, and release them within 0.25 miles of capture site. Radio transmitters (0.5-1.2 g) emitting unique frequencies will be attached with glue to the lower back (*53*) of rails weighing more than 24 g (*54*).

Observers will track radio-marked birds mainly from null-peak telemetry equipped trucks, but will also use handheld antennas to obtain visual observation of marked birds. Locations will be obtained for every marked bird on high and low tides and plotted in a GIS with detailed wetland coverages of the Bay to determine habitat use and foraging areas, including channel order and distance from cover. Foraging location data will be used to determine prey-sampling locations. Observations after the third day from

marking to allow for behavioral adjustments to the radios (*55, 56*) will be used to calculate home range size (*57*).

The study will include prebreeding, breeding, and postbreeding stages in the winter to summer. We will locate nests and examine rail eggs and recording egg length, width, weight, volume, and eggshell thickness near the equator of each egg (to nearest micron) to compare with reference collections. Virginia and fail-to-hatch black rail egg samples will be collected during breeding season. Fail-to-hatch clapper rail eggs may also be collected opportunistically as they are found. Birds will be resighted and nests revisited to examine Hg and MeHg effects on reproductive success. Egg concentrations will be compared to those in blood and feathers of adults (*58*). MeHg/Hg analyses will be performed by USGS (Wisconsin) or a contract laboratory selected by the co-PIs, and C and N stable isotopes will be analyzed by UC Davis with additional subcontracts for S as needed. All rail work will be done by USGS BRD staff and Dr. Evens under federal and state permits and review by the USGS Animal Care and Use Committee.

Differing food web structure within and among marshes could potentially influence Hg concentrations. Stable nitrogen isotopes are often used to determine trophic levels ingested by target organisms, but results are influenced by a mixture of prey types, with differences in dietary ^{15}N content (*59*), and differences in ^{15}N fractionation among invertebrate species (*60*). Therefore, we propose to also look at C and S stable isotopes in blood, fail-to-hatch eggs, and prey items to determine trophic webs (*61*) for rails, supplemented with gut analyses of the Virginia Rail (*62*).

Diet items of specific birds will be identified through a combination of methods. Prey item species from each site will be collected and sorted, then selected based on abundance or observed or documented rail feeding on those species. Samples will be composited at genus or higher taxonomic levels when sufficient biomass for composites of individual species cannot be found at a site within each rail foraging area. Initially subsamples of the composites will be analyzed for C, N, and S stable isotopic signatures, which will likely vary between microhabitats (*12, 62*). For those prey items deemed most likely to be important diet components, MeHg analysis will follow.

We will characterize habitat use during high and low tides, and relate home ranges to wetland size, proportion of upland refugia, degree of isolation, and channel order through aerial photographs and GIS coverages. Tidal influence (*50*), salinity of nearest channel or waterway, channel cross sections (aerial photos, LIDAR, ecosounder), and vegetation characteristics (*63*) will be measured within the determined home range of the rail species. Habitat preferences will be related to physical (wetland size or isolation, hydrology) and biological (vegetation structure and composition) characteristics with compositional analysis (*64, 65*). Regression analyses will be used to relate substrate and water mercury concentrations to habitats and prey items consumed by rails.

Target fish species include inland silversides, staghorn sculpin, prickly sculpin, juvenile striped bass, and yellowfin goby. Inland silversides should be present in all of the marshes and have been found to be an effective indicator of Hg distribution (*24*). The other species are abundant predators that reside in marshes and would be expected to accumulate higher Hg concentrations. Sculpin and striped bass are successfully being sampled in a separate SFEI study of two marshes in San Pablo Bay. Abundant smaller fish (e.g. silversides) will be analyzed as multi-individual composites. Striped bass are larger and less abundant and will be analyzed as individuals. Compositing strategies will

be employed for other species depending on their size and abundance. Fish will be sampled yearly in the summer using an otter trawl in the larger channels and beach seines or other devices (e.g. dip nets) in the shallower waters. Fish samples will be collected, frozen and sent to the lab for homogenization and analyses.

f. Quality assurance

A quality assurance project plan will be established using the CalFed ERP template. Aside from duplicate samples collected in the field, labs will be required to run duplicate analyses of field and control samples to ensure adequate performance. Analyses failing data quality criteria will be reanalyzed as needed. Some samples (~5%) will be split and exchanged among labs analyzing similar matrices in this study. If the CalFed ERP establishes a mercury QA/QC program, split samples would be analyzed for that program as well.

4. Feasibility

The collection methods and analyses described for sediment and water samples are similar to those used previously in studies of Hg and MeHg in other fresh and marine environments (*8, 12, 66*). Incubation experiments for sulfate reduction, Hg methylation, and MeHg demethylation rate measurements follow methods of previously published work. Sampling sites are on public lands, and sampling is neither so extensive nor so frequent that lasting observable impacts on the sites would be expected. Eggs of endangered California clapper rails are collected only if found non-viable.

Collaborating partners on this proposed project have successfully performed similar studies for the portions of the project for which they are responsible (see qualifications), in this region and others. There are competent commercial laboratories that can perform some of the chemical analyses (e.g. Frontier Geosciences, Battelle, for Hg and MeHg measurements) for approximately the same cost if needed, should unanticipated demands on their time arise. However, the number of sites and sampling frequency were chosen with the availability of these collaborators and their staff in mind.

5. Performance Measures

High quality peer review is one of the best ways to ensure that the project products successfully meet objectives. Project performance can be evaluated by accomplishment of the following measures:

- Formalize agreements with collaborating partners
- Submit quarterly fiscal and programmatic reports
- Refine and approve of annual sampling plans through peer review
- Sample all matrices successfully
- Meet Chemical analyses data quality criteria
- Complete chemical analyses and QA/data reports within 5 months of sampling
- Complete peer-reviewed annual project findings and progress reports for CalFed
- Present findings at review meetings
- Produce peer-reviewed final report
- Present findings and raw data on the web
- Publish results in peer-reviewed journals

Success can be quantified by the timeliness, quantity, and quality of these products.

One important goal of the first year of sampling and analysis will be re-evaluation of the conceptual model, particularly the activities of the higher trophic level species of interest (e.g., rails) in the wetland ecosystem. For example, if rails are found to be

foraging only smaller channels, sampling of larger channel benthos will be scaled back or eliminated. Other conceptual assumptions about Hg/MeHg distribution, transformation, and bioaccumulation will be similarly evaluated. However, care will be taken not to alter the sampling plan drastically (particularly in eliminating measurements) unless there is substantial evidence that the conceptual model is incorrect, not just the result of temporal or spatial variability.

6. Data Handling and Storage

All data generated in the field and through laboratory analyses will be kept on a microcomputer database server at SFEI. The server is backed up weekly and copies kept offsite. Subsets of the data can be generated and exported to common formats for use by collaborators and other interested parties. SFEI will manage the data from this study using procedures developed for the Regional Monitoring Program, which has successfully managed data for regional efforts for over seven years. Analytical results will be transferred to SFEI in spreadsheets or other electronic formats by the laboratory and compiled into an Oracle database, which will be maintained by SFEI. To minimize data formatting by SFEI staff, templates and guidelines explaining the structure of the database tables will be provided to the laboratories. Data will be reviewed to ensure consistency with the master database format. Results will be compiled (e.g. site, date, variable, result) for QA review and reporting, and will be made accessible through SFEI's website. Tools being developed by SFEI for the Wetlands Regional Monitoring Pilot for CalFed may also be used to facilitate data sharing and review.

7. Expected Products

Primary products of this research project will be reports and presentations including the following:

- Annual peer-reviewed sampling plan
- Quality assurance project plan
- Annual peer-reviewed project reports with preliminary data and interpretation
- Presentations at annual review meetings and symposia
- Peer-reviewed final report
- Peer-reviewed journal publications

Performance can be judged through successfully passing the peer-review process.

All co-PIs will meet at least twice a year (in real and/or virtual conferencing) to discuss and integrate findings across the sampling strata (elevation, salinity, marsh physiography). In addition to statistical analyses and other quantitative methods, data will be presented using geographical tools to find unexpected patterns or relationships in Hg/MeHg distribution and bioaccumulation and identify additional data needs that could help better explain the observed results. This forum for sharing information will require the co-PIs to evaluate the project beyond just the scope of work they individually perform and use all the data to a more comprehensive picture of the marshes as a whole. The annual CalFed meeting among mercury research projects could serve as one of those meetings and also as a template for meetings within this group of PIs.

8. Work Schedule

Table 1 presents the proposed work schedule for this project. Project management is an ongoing task throughout the project, including financial tracking and other administrative tasks. More discrete project management tasks will involve an annual planning and evaluation cycle for the project, beginning with the initial project planning

and coordination, and recurring each year in reviewing the data and adjusting the project plan. Given the timing of the CalFed award schedule, the likely option is to delay most project implementation until 2004, with a small effort to scout for rails and suitable sampling sites in late 2003.

Wetlands sediment and water should not be sampled for Hg and MeHg without sampling of the biological matrices (benthos, fish, bird eggs). Although monitoring all organisms at the proposed frequency may not be necessary, not monitoring biota would not provide the information needed to meet CalFed ERP goals. Sampling of fish and benthos could be scaled back if the temporal variability in community structure and contaminant concentrations were found to be insignificant. Payments could be tied to annual reporting and sampling plan revision products described.

B. APPLICABILITY TO CalFed GOALS AND PRIORITES

1. Applicability To ERP, Science Program and CVPIA Priorities

This proposal addresses restoration priorities for the Bay region BR-4, and BR-5, and multi-regional priority MR-5. An information gap currently exists on the extent and impact of Hg contamination in tidal wetlands. This study will complement past and current efforts investigating Hg contamination in the Delta. We will be directly investigating Hg impacts on an endangered/threatened bird species (California clapper/black rail) and bioaccumulation in a sportfish (striped bass) commonly consumed by humans.

Benefits of this information extend beyond these particular species; by measuring Hg in organisms from lower trophic levels and Hg transformation processes in tidal marsh sediments and waters, we aim to better understanding of mechanisms of Hg impact on wetlands biota. This information can be used in design of monitoring strategies using similar sampling stratification schemes and to place in context factors confounding simple analyses of mercury contamination in this region and others. By including sites along a salinity gradient and through an age progression of marsh development, we aim to explore factors for evaluating sites in similar watersheds and project short and long term behavior of regional restored wetland ecosystems. By identifying factors that would indicate a high risk for Hg contamination and bioaccumulation in wetlands, this data would allow managers to make appropriate decisions on how to manage or avoid such risks in choosing and designing restoration projects.

2. Relationship to Other Ecosystem Restoration Projects

This project would complement current and past CalFed efforts investigating mercury in the Delta and a UC Davis project on Effects of Wetlands Restoration on Methyl Hg Levels. The Petaluma River Watershed Restoration Program and Petaluma Marsh Expansion are progressing/planned in or near the study area. Co-PIs on this project are also working on or proposing other projects related to mercury. Dr. Collins is developing a plan for a regional wetlands monitoring program, for which data and methods from this study can be incorporated into a monitoring strategy. Dr. Davis is submitting a proposal for this round of CalFed ERP funding, monitoring fish of the Delta and Central Valley. Dr. Schwarzbach is proposing investigations of Hg bioaccumulation of birds that focuses on other guilds of concern. Dr. Marvin-DiPasquale is proposing work investigating Hg biogeochemistry in the Delta. These proposed studies are similarly concerned with mercury, but address different processes and have other temporal and spatial focus from this proposal. There is therefore no overlapping effort.

3. Request for Next Phase Funding

This proposal is not a request for next phase funding.

4. Previous Recipients of CalFed Program or CVPIA Funding

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

SFEI: *CalFed Whitepaper on: Ecological Processes in Tidal Wetlands of the Sacramento-San Joaquin Estuary and Their Implications for Proposed Restoration Efforts of the Ecosystem Restoration Program.* Dr. Davis was lead author of chapter: "Issues in San Francisco Estuary tidal wetlands restoration: Potential for increased mercury accumulation in the Estuary food web." submitted to CalFed Science Journal.

5. System-Wide Ecosystem Benefits

There is an opportunity for synergy with the Petaluma River Watershed Restoration Program and Petaluma Marsh expansion, among other projects. This study could inform these projects and others on possible Hg contamination issues in wetland restoration, and information developed by the West Coast Wetlands Monitoring Venture, Breech II, other regional efforts can be used to refine sampling design and data interpretation for this project.

C. QUALIFICATIONS

This project is organized as a joint venture partnership. SFEI will be the lead contracting party as it does not apply a blanket overhead to pass-through funds to outside researchers. Project management is included as a separate task in the proposal budget. Although some tasks (e.g. sampling) are performed in concert with collaborating partners, this is included under the separate overall task for each partner individually (e.g. Microbial Transformation Rates). Should a partner be unable to perform a task, it is the responsibility of that partner to find a suitable replacement or subcontractor to perform the work.

The following investigators from SFEI are listed alphabetically:

Joshua N. Collins, Ph.D., SFEI, Environmental Scientist

Dr. Collins received his Ph.D. in Entomological Sciences at the University of California at Berkeley and has done post-doctoral studies in Geography and Ecology at the University of California at Berkeley and Davis. Dr. Collins is a landscape ecologist and regional ecological planner with special expertise in the evolution and natural maintenance of streams and wetlands. He has published original research on plant-vertebrate interactions, contamination in marshes, tidal marsh hydrology and geomorphology, and evolution of wetland landscape. Dr. Collins has over 25 years of research experience in Bay Area wetlands. Since Dr. Collins joined the staff of SFEI in 1993, he has been the principal author and lead scientist for the Bay Area Wetlands Monitoring Plan, the Bay Area Watersheds Science Plan, the Bay Area EcoAtlas, and the Bay Area Regional Wetlands Ecosystem Goals Project. Dr. Collins oversees the SFEI Wetlands Science Program.

Jay A. Davis, Ph.D., SFEI, Environmental Scientist

Dr. Davis has performed research on contaminant issues in the Bay-Delta for 15 years. The accumulation and effects of persistent, bioaccumulative toxicants has been an area of particular emphasis. Dr. Davis has been principal investigator on several studies of contaminant accumulation in fish, including: 1) CalFed Mercury Project; 2) fish contamination monitoring element of the Regional Monitoring Program (RMP) for San Francisco Bay; 3) fish contamination monitoring in the Sacramento River Watershed Program; 4) The Delta fish contamination study; 5) Chronic Toxicity of Environmental Contaminants in Sacramento Splittail: A Biomarker Approach; and 6) Coastal Intensive Site Network: San Pablo Bay. In addition to the fish work, Dr. Davis is part of a team that manages the RMP, a $3 million/year program that monitors toxic chemicals in San Francisco Bay water, sediment, and biota. Drawing on his experience with all of these projects, Dr. Davis was lead author of the chapter "Mercury and Tidal Wetland Restoration" in the CalFed Whitepaper: "Ecological Processes in Tidal Wetlands of the Sacramento-San Joaquin Estuary and Their Implications for Proposed Restoration Efforts of the Ecosystem Restoration Program" (draft).

Donald Yee, Ph.D., SFEI, Environmental Scientist

Dr. Yee will take the lead role in project management and administrative duties, including coordination and reporting tasks. Dr. Yee is the Quality Assurance Officer for SFEI and is part of the RMP management team. He is also involved in other projects investigating contaminant sources, transport, and fate in the Estuary, including a RMP pilot study on atmospheric deposition of mercury (with one site on the national MDN) and other contaminants, and was a co-author on the CalFed whitepaper led by Dr. Davis. Dr. Yee received his B.S. in Chemical Engineering and his Ph.D. in Environmental Engineering from M.I.T. His dissertation research with Dr. Francois Morel focused on aqueous trace metal speciation and competitive interactions in microorganisms. His experience prior to joining SFEI in 1999 included research on carbon geochemistry and private sector consulting on environmental regulatory policy.

Collaborating Principal Investigators:

The following researchers will be collaborating on this project as a joint venture partnership.

Steven Schwarzbach, Ph.D., U.S. Geological Survey (Biological Resources Division)

Dr. Schwarzbach will direct the team monitoring and sampling rails. Dr. Schwarzbach served as chief of the Environmental Contaminants Division of the Sacramento Field Office, USFWS and is now with USGS BRD. He has designed and directed multidisciplinary field studies of environmental contaminant impacts to fish and wildlife in California including studies in intertidal marshes of San Francisco Bay. Studies in which Dr. Schwarzbach has been involved have focused on contaminants including mercury, selenium, acid mine drainage, and eutrophication effects upon water quality. His personal scientific interests have most recently been particularly focused on mercury and selenium in birds of the San Joaquin Valley and San Francisco Bay. He has directed field investigations on contaminant hazards to clapper rails in South Bay in 1991 and 1992 and North Bay in 1998 and 1999 and directed a baywide investigation of mercury bioaccumulation in birds of San Francisco estuary for CalFed and the Regional Water Quality Control Board. Steven Schwarzbach is currently working on the CalFed mercury study in the Delta (tracking number 99-B06).

John Y. Takekawa, Ph.D., U. S. Geological Survey (Biological Resources Division)
Dr. Takekawa will be co-PI on the field rail monitoring and sampling team. His experience includes 15 years as a federal research biologist in California, specializing in ecology of migratory waterbirds with technical specialty in application of radio telemetry. His research has focused on the Pacific Rim, California, and SFB. Dr. Takekawa has also served as Goals Project Focus Team co-chair, BCDC Subtidal Habitats panel, NOAA Airport Runways panel, established the USGS SFB Estuary Field Station in 1995. His PhD in 1987 form Iowa State Univ. was in Animal Ecology/Statistics minor, with a MS 1982, Univ. of Idaho, in Wildlife Resources, and a BS 1979, Univ. of Wash., Seattle in Wildlife Science/Forestry.

Jules Evens, Ph.D., Avocet Research Associates
Dr. Evens will be co-PI on the rail monitoring and sampling team. Dr. Evens is principal for Avocet Research Associates and Research Associate with the Point Reyes Bird Observatory. He has almost 30 years experience as a field biologist with expertise in rare, threatened, and endangered birds of tidal marshes, with over 20 years experience in the SFB tidal marshes. Dr. Evens expertise in avian population dynamics, ecology, biological assessment, monitoring, and field biology, includes published work on California clapper and black rails. He has worked with numerous state, federal, and non-profit agencies.

Mark Marvin-DiPasquale, Ph.D. U.S. Geological Survey (Menlo Park, CA)
Dr. Marvin-DiPasquale is leading the team investigating Hg microbial transformations, and his lab will be performing sediment and pore-water ancillary measurements, and analyses of the pore-water parameters in surface water. Dr. Mark Marvin-DiPasquale completed his Ph.D. in estuarine microbial ecology in 1995 at the University of Maryland. He has been with USGS since then and has focused his efforts on the microbial cycling of mercury in ecosystems throughout the U.S. Mark was a co-PI on the Aquatic Cycling of Mercury in the Everglades (ACME) Project. He conceptualized, coordinated, and conducted a major EPA sponsored study of the microbial cycling of mercury in sediments, which included the simultaneous assessment of mercury-methylation and demethylation along a 100 km stretch of the Carson River and associated wetlands. He has collaborated with junior scientists from UC Santa Cruz investigating mercury cycling associated with the New Idria Mercury mine (California), the first examination of microbial methylmercury degradation processes in such a mining area. He has collaborated with USGS colleagues in assessing microbial mercury cycling in historically mercury impacted gold/silver mining areas in the Sierra Nevada and San Francisco Bay. Mark has been lead author on 5 peer reviewed journal papers or book chapters, and has been a co-author on a number of others and has served as a colleague reviewer on over a 20 peer reviewed published articles.

David Krabbenhoft, Ph.D., U.S. Geological Survey (Wisconsin)
Dr. Krabbenhoft is leading the team measuring Hg and MeHg in sediment, water, and biota samples, photo-demethylation rate experiments, and water DOC measurements. Dr. David Krabbenhoft is a senior research scientist with the U.S. Geological Survey. He has general research interests in geochemistry and hydrogeology of aquatic ecosystems. Dave began working on environmental mercury cycling, transformations, and fluxes in aquatic ecosystems after completing his Ph.D. 1988, and the topic has consumed him since. For the past 4 years he has served as the project leader for the USGS National Mercury

Project. This project is responsible for the execution of studies that will lead to a better understanding of mercury contamination of aquatic ecosystems at the national scale. In 1995 Dave established the USGS Mercury Research Laboratory in Wisconsin. This laboratory is a state of the art, analytical facility strictly dedicated to the analysis of mercury, with low-level speciation. Recently, they acquired a Quadra-pole, ICP-MS dedicated for the analysis of mercury isotopes that are used at several research sites to further our understanding of the important pathways and controlling processes of mercury in the environment.

D. COST

The budget is provided via the web form. There are no plans for cost sharing.

E. LOCAL INVOLVEMENT

This research project will have minimal physical impacts on the system.

F. COMPLIANCE WITH STANDARD TERMS AND CONDITIONS

The applicants will comply with all state and federal standard terms.

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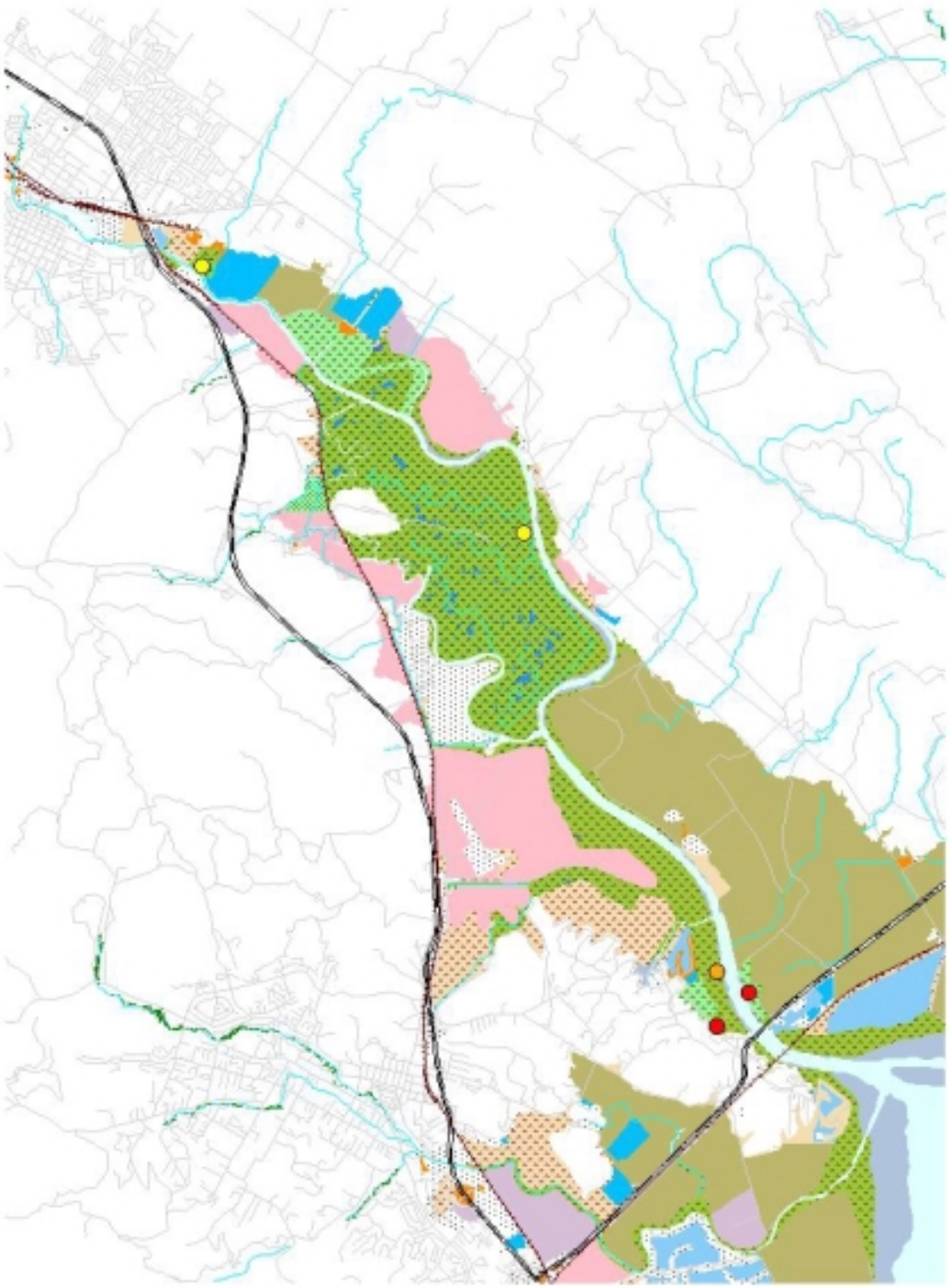

Figure 1 Petaluma River Tidal Wetland Study Locations –Three marshes (2 red, 1 orange point) at the mouth of the Petaluma River near Highway 37 cover a range of marsh ages of 10, 50-100, and 500+ years. The two yellow points up the river and the orange point at the mouth cover a range of salinity for tidal wetlands 50-100 years old.

Table 1 PROJECT TIMELINE