Analysis Of Archived Samples To Assess Patterns Of Historic Invasive Bivalve Biomass

submitted to Science Program 2006

compiled 2006–11–09 17:44:20 PST

lead investigators:
Messer, Dean

Project Information And Executive Summary

Analysis Of Archived Samples To Assess Patterns Of Historic Invasive Bivalve Biomass

This is proposal #0078 for the Science Program 2006 solicitation.

Frequently asked questions and answers for this PSP are now available.

The submission deadline for this proposal has passed. Proposals may not be changed.

Instructions

Please complete the Project Information and Executive Summary Form prior to proceeding to the other forms contained on this website and required to be completed as part of your PSP application submittal. Information provided on this form will automatically support subsequent forms to be completed as part of the Science PSP submission process. Information provided on this form will appear in the Contacts and Project Staff, Task and Budget Summary, and Conflict of Interest forms.

Proposal Title: **Analysis of Archived Samples to Assess Patterns of Historic Invasive Bivalve Biomass**
This field is limited to 255 characters. All proposal titles must be entered in title case. No abbreviations or acronyms will be accepted.

Applicant Information

Applicant Organization Name: **California Department of Water Resources**
Please provide the name of the organization submitting the application as follows: Davis, California University of; Fish and Game, California Department of; California Waterfowl Association, etc.

Applicant Organization Type:
State agency
eligibility

Below, please provide contact information for the representative of the applicant organization who is authorized to enter into a contractual agreement with the State of California and who has overall responsibility for the operation, management, and reporting requirements of the applicant organization. (This should be the same individual who signs the signature page.)

Salutation: **Ms.**
First Name: **Barbara**
Last Name: **McDonnell**
Street Address: **901 P Street (4th Floor)**
City: **Sacramento**
State or Province: **CA**
Zip Code or Mailing Code: **94236**
Telephone: **(916) 651-9777**
E-mail Address: **bmcdonne@water.ca.gov**

Below, please provide contact information for the primary point of contact for the implementation of the proposal. This person should be the same individual who is serving as the project Lead Investigator/Project Director.

Salutation: **Dr.**
First Name: **Dean**
Last Name: **Messer**
Telephone: **(916) 651-0168**
E-mail Address: **dmesser@water.ca,gov**

Proposal Information

Total Amount Requested: $219,822

The figure represented above is provided by the total amount requested on your completed Task and Budget Summary Form. The applicant must ensure the amount indicated above is correct and equal to the total amount requested in the budget document uploaded via the Budget and Justification Form for this project.

Select one primary and up to three secondary topic areas that best apply to this proposal:

Aquatic Invasive (Exotic) Species (Primary)

Trends and Patterns of Populations and System Response to a Changing Environment

Habitat Availability and Response to Change

Select up to five keywords to describe this project.
– ***agriculture***
– ***agricultural economics***
– ***agricultural engineering***
– ***agronomy***
– ***agro−ecology***
X ***benthic invertebrates***
X ***benthos***
– ***biochemistry***
– ***biological indicators***
– ***birds***
– ***channels and sloughs***
– ***climate change***
– ***conservation or agricultural easements***
– ***conservation program management***
– ***database management***
– ***ecotoxicology***
– ***economics***
– ***engineering***
– ***erosion control***
– ***environmental education***
– ***evapotranspiration***
– ***fish biology***
– delta smelt
– salmon and steelhead
– other species
– otoliths
– tagging
– ***fish management and facilities***
– ***flooded islands***
– ***floodplains and bypasses***
– ***forestry***
– ***genetics***
– ***geochemistry***
– ***geographic information systems (GIS)***
– ***geology***
– ***geomorphology***
– ***groundwater***
– ***human health***
– ***hydrodynamics***
– ***hydrology***
– ***insects***
– ***integrated pest management***
– ***integrated resource planning***
X ***invasive species / non−native species / exotic species***
– ***irrigation systems***
– ***land use laws and regulations***
– ***land use management***
– ***land use planning and policy***
– ***levees***
– ***mammals***
– ***microbiology / bacteriology***
– conceptual
– quantitative
– ***oceanography***
– ***performance measures***
– ***phytoplankton***

– ***plants***
– terrestrial
– aquatic
– wetland
– ***remote sensing / imaging***
– ***reptiles***
– ***reservoirs and lakes***
– ***restoration***
– ***riparian zone***
– ***rivers and streams***
– ***sediment***
– ***soil science***
– ***statistics***
– ***subsidence***
– ***sustainable agriculture***
X ***trophic dynamics and food webs***
– ***water operations (diversions, pumps, intakes, exports, barriers, gates, etc.)***
– ***water quality***
– other
– temperature
– contaminants
– nutrients, organic carbon, and oxygen depleting substances
– salinity
– sediment and turbidity
– ***water supply***
– ***watershed assessment***
– ***watershed management***
– ***wetlands***
– ***zooplankton***

Provide the geographic coordinates that best describe the center point of your project. (Note: If your project has more than one site, provide a center point that best captures the central location.)

Example:	Latitude:	38.575; must be between 30 and 45
	Longitude:	−121.488; must be between −120 and −130

Help for finding a geographic location.

Latitude: **38.032**
Longitude: **−121.589**

Provide the number miles radius from the center point provided above, to demonstrate the radius of the entire project.
35

Provide a description of the physical location of your project. Describe the area using information such as water bodies, river miles and road intersections.

This project will analyze archived benthic samples taken from sites throughout the upper San Francisco Estuary – San Pablo Bay, Suisun &Grizzly bays, and the Sacramento–San Joaquin Delta.

Successful applicants are responsible for complying with all applicable laws and regulations for their projects, including the National Environmental Policy Action (NEPA) and the California Environmental Quality Act (CEQA). Projects funded through this PSP that tier off the CALFED Programmatic EIS/EIR must incorporate applicable mitigation strategies described in the CALFED Programmatic Record of Decision to avoid or minimize the project's adverse environmental impacts. Applicants are encouraged to review the Programmatic EIS/EIR and incorporate the applicable mitigation strategies from Appendix A of these documents for their projects.

If you anticipate your project will require compliance of this nature (ie applications for permits, other environmental documentation), provide below a list of these items, as well as the status of those applications or processes, if applicable. If you believe your project will not require these regulatory actions, please provide one or two lines of text outlining why your proposed project will not be subject to these processes. Further guidance is available in The Guide to Regulatory Compliance for Implementing CALFED Activities.

This project does not include a field component. The project will analyze archived benthic samples. The project WILL NOT require any further sampling at any locations.

Is this proposal an application for next phase funding of an ongoing project funded by CALFED Science Program?
x No. **–** Yes.

If yes, identify the ongoing project:

Project Title:
CALFED Contract Management Organization:
Amount Funded:
Date Awarded:
Lead Organization:
Project Number:

Have primary staff and/or subcontractors of the project team (those persons listed on the Contacts and Project Staff form) received funding from CALFED for a project *not* listed above?
x No. **–** Yes.

If yes, list the projects below: (only list up to the five most recent projects)

Project Title:
CALFED Contract Management Organization:
Amount Funded:
Date Awarded:
Lead Organization:
Project Number:

Project Title:
CALFED Contract Management Organization:
Amount Funded:
Date Awarded:
Lead Organization:
Project Number:

Project Title:
CALFED Contract Management Organization:
Amount Funded:
Date Awarded:
Lead Organization:
Project Number:

Project Title:
CALFED Contract Management Organization:
Amount Funded:
Date Awarded:
Lead Organization:
Project Number:

Project Title:
CALFED Contract Management Organization:
Amount Funded:
Date Awarded:
Lead Organization:
Project Number:

Has the Lead Investigator, the applicant organization, or other primary staff or subcontractors of your project team ever submitted a proposal for this effort or a similar effort to any CALFED PSP?
– No. **x** Yes.

If yes, list the submission below: (only list up to the five most recent projects)

Project Title: **Long-Term Trends in Benthic Macrofauna Biomass in the Upper San Francisco Estuary**
CALFED Program: **Science Program 2004 Solicitation – Proposal #0205**
Date of PSP: **2004**

Project Title:
CALFED Program:

Date of PSP:

Project Title:
CALFED Program:
Date of PSP:

Project Title:
CALFED Program:
Date of PSP:

Project Title:
CALFED Program:
Date of PSP:

Note: Additional information on this or prior applications submitted –– or proposals funded –– may be required of applicants.

List people you feel are qualified to serve as scientific and/or technical reviewers for this proposal and are not associated with your organization or CALFED.

Full Name	Organization	Telephone	E–Mail	Expertise
Wim Kimmerer	San Francisco State University	(415) 338–3515	kimmerer@sfsu.edu	

Provide additional comments, information, etc. here:

Executive Summary

Provide a brief but complete summary description of the proposed project; its geographic location; project objective; project type, approach to implement the proposal; expected outcomes; and adaptive management approach and relationship to the Science Program goals. The Executive Summary should be a concise, informative, stand–alone description of the proposed project and be no longer than one page in length. Please note, this information will be made public on our website shortly after the closing date of this PSP.

EXECUTIVE SUMMARY

Analysis of Archived Samples to Assess Patterns of Historic Invasive Bivalve Biomass

Two species of invasive bivalve are dominant in the upper San Francisco Bay–Delta system; Corbula amurensis, and Corbicula fluminea. These invasive bivalves are considered to be a major sink of primary productivity in the San Francisco Bay – Delta system. Research conducted since their introductions showed that seasonal phytoplankton blooms disappeared after these bivalves invaded the upper San Francisco Estuary. Sacramento–San Joaquin River Delta habitats where Corbicula fluminea are abundant were found to be net sinks to phytoplankton biomass. The recently recognized declines in several Delta fish populations have heightened interest in the pelagic food web of the San Francisco Bay–Delta system. Several populations of fish that prey on zooplankton are in decline. Several populations of primary consumers (zooplankton) have declined in recent decades, contemporaneously with the introduction the invasive bivalve Corbula amurensis and appear to be food limited. Recent research supports the concept that bivalve grazing is an important factor in determining overall ecosystem function in the San Francisco Bay–Delta system. Thus, investigations of invasive bivalve population dynamics and grazing pressure over temporal and spatial gradients are important as CALFED considers restoration plans for the system. Because benthic bivalves are both ubiquitous and abundant in the upper estuary and dominant in macrobenthic assemblages, accurate estimates of bivalve biomass are necessary for assessment of transfer of not only carbon, but also contaminants among the food webs in this system. Invasive bivalve species have been found to assimilate trace contaminants in this system, and are known to transfer contaminants among trophic levels within the food web. This study proposes to address changes in invasive bivalve populations over time by analyzing archived samples from monthly or near–monthly monitoring, conducted over a 30 year time period in the lower Sacramento River and in the lower San Joaquin River system. The objectives of the proposed research project are: (1) to obtain biomass data from benthic samples collected at two long term monitoring sites sampled by the IEP EMP in the San Francisco Bay–Delta system, and for benthic samples collected during an IEP EMP special study of small scale variability in benthic assemblages near six long–term monitoring locations; (2) make these data available to researchers and the public in a useful form; (3) use the data to evaluate trends in the biomass of invasive bivalve species over nearly 30 years, as well as patterns of invasive

bivalve biomass over spatial gradients in the upper San Francisco Estuary. These analyses will provide information to aid in analysis of uncertainty regarding the effect of bivalves in restored habitat by assessing patterns of invasive bivalve biomass. The analyses proposed for this project address abiotic (temperature, salinity, depth, flow, turbidity, and contaminants), and biotic (natural population cycles, response to other invasives, competitors, predators, etc.) factors that have been associated with fluctuations in bivalve biomass characteristics in the past. Trends and patterns of populations and system response to a changing environment will also be assessed by this project. Assessment of historical samples with excellent temporal and spatial resolution will help CALFED address how invasive bivalve populations and their effects might respond to present and future dynamics of populations of key species, system operations and anticipated environmental changes based on patterns seen in historic samples. This study will discuss the implications for management strategies of the species responses seen over time and space in the system and discuss models that are needed to describe driver/response relationship. Assessment of patterns of invasive bivalve biomass in the San Francisco Bay-Delta system will also help inform projections of the extent and quality of Delta habitat for key species, especially with regard to the affects of invasive species, and how future scenarios will be affected by biotic drivers. This project represents a unique opportunity to use existing biological samples to learn more about how processes in the benthic community affect ecological processes that are critical to our understanding of the ecosystem and the long term trends in at-risk species in the SFE. It will benefit the CALFED Program by providing a more suitable data and information foundation for the modern ecosystem-based adaptive management strategies adopted by CALFED and by increasing the understanding of ecological and biochemical processes involving benthic organisms. This increased understanding is especially needed to achieve the goals of the CALFED Ecosystem Restoration Program, including management of at risk and harvestable species, restoration of natural processes and habitats, reduction of the impact of invasive species, and improvement of water and sediment quality The project will be a collaborative effort between the California Department of Water Resources (DWR) and the United States Geological Survey. The project will be undertaken and carried out as three highly integrated tasks (Biomass Measurement, Data Storage and Management and Data Analysis). Contract management and coordination will be through DWR.

Contacts And Project Staff

This is proposal #0078 for the Science Program 2006 solicitation.

Frequently asked questions and answers for this PSP are now available.

The submission deadline for this proposal has passed. Proposals may not be changed.

INSTRUCTIONS

Use this form to provide titles, affiliations, qualifications, and descrptions of roles of the primary and secondary project staff. Include any consultants, subcontractors and/or vendors. The Lead Investigator or Project Director, as identified in the Project Information and Executive Summary Form, is required to upload a PDF version of their resume. To complete the qualification field of this form, please provide a bulleted list of relevant project/field experience and any publications/reports that support your participation in the proposed project.

Information provided on this form will automatically support subsequent forms to be completed as part of the Science Program PSP submission process. Please note tht information you enter in this form will appear in the Task and Budget Summary and Conflict of Interest forms.

Information on subcontractor services must be provided even if the specific service provider has not yet been selected. If the specific subcontractor has not been identified or selected, please list TBD (to be determined) in the last name field and the anticipated service type in the title field (example: Fish Biologist).

Please provide this information before continuing to the Tasks and Deliverables Form.

Applicant

California Department of Water Resources
Ms. Barbara McDonnell
901 P Street (4th Floor)
Sacramento CA 94236
(916) 651–9777
bmcdonne@water.ca.gov

Lead Investigator/Project Director

Salutation: **Dr.**
Last Name: **Messer**
First Name: **Dean**
Title: **Senior Environmental Scientist**
Organization: **California Department of Water Resources**
Responsibilities: **Project Management and Coordination**
Resume:

You have already uploaded a PDF file for this question. Review the file to verify that appears correctly.

Mailing Address: **901 P Street (4th floor)**
City: **Sacramento**
State: **California**
Zip: **94236**
Telephone: **(916) 651–0168**
E–Mail: **dmesser@water.ca,gov**

All Other Personnel

Salutation: **Mrs**
Last Name: **Gehrts**
First Name: **Karen**
Title: **Environmental Scientist**
Organization: **DWR**
Position:

primary staff
Responsibilities: **Task 1, 2 and 3**
Qualifications:

Curriculum Vitae: Karen Gehrts California Department of Water Resources Division of Environmental Services Monitoring and Analysis Branch 901 P Street, 4th Floor Sacramento, CA

Phone: (916) 651-0190 E-mail:kagehrts@water.ca.gov

Education: University of California at Davis, B.S., Environmental Resource Science

Research and Professional Experience: 2000 - present Environmental Specialist (intermittent), California Department of Water Resources, Sacramento, CA 1999 - 2000 Scientific Aid, California Department of Water Resources, Sacramento, CA

Research Interests: Benthic invertebrate ecology and exotic species invasions

Presentations: Gehrts, K (2006) Environmental Monitoring Program, Proposed changes to the Benthic Monitoring Element. Presentation, Regional Monitoring Program, Oakland, CA.

Gehrts, K (2004) Environmental Monitoring Program Update. Presentation, IEP Conference, Lodi, CA.

Gehrts, K., Mueller-Solger, A., (2002) Benthic Biomass: Why Measure it? A Presentation to the IEP Management Team. Davis, CA.

Publications:

Lehman, P., G. Boyer, C. Hall, S. Waller, and K. Gerhts (2005) Distribution and toxicity of a new colonial Microcystis aeruginosa bloom in San Francisco Estuary, California. Hydrobiology. 541:87-99.

Lehman, P. W., S. Waller, G. Boyer, and K. Gehrts (2004) Distribution and toxicity of a new Microcystis aeruginosa bloom in the upper San Francisco Bay region. Technical Report prepared for NOAA Coastal Ocean Program Monitoring and Event Response for Harmful Algal Blooms. 17 p

Gehrts, K., Phillippart, S., Messer, C. (2004) Status and Trends, Benthic Monitoring 2003 http://www.iep.ca.gov/report/newsletter/2004_newsletters/IEPNewsletter_spring_2004.pdf

Gehrts, K., Phillippart, S., Messer, C. Status and Trends, Chlorophyll and Phyotplakton Monitoring 2003 http://www.iep.ca.gov/report/newsletter/2004_newsletters/IEPNewsletter_spring_2004.pdf

Gehrts, K (2003) Status and Trends, Benthic Monitoring 2002 http://www.iep.ca.gov/report/newsletter/2003spring/IEPnewsletterSpring.pdf

Gehrts, K (2003) Status and Trends, Chlorophyll and Phyotplakton Monitoring 2002 http://www.iep.ca.gov/report/newsletter/2003spring/IEPnewsletterSpring.pdf

Gehrts, K (2002) Benthic Monitoring, Database Updates http://www.iep.ca.gov/report/newsletter/2003winter/IEPnewsletterFall2002.pdf

Gehrts, K (2002) Water Year Hydrologic Indices for the Sacramento and San Joaquin Valleys http://www.iep.ca.gov/report/newsletter/2002winter/IEPNewsletterWinter2002.pdf

Gehrts, K (2002) Phyotplankton and Benthos abundance and distribution in the upper San Franciscio Estuary 2001 http://www.iep.ca.gov/report/newsletter/2002spring/IEPNewsletterspring2002.pdf

Posters: Gehrts, K. and Barnett, R. (2006) The Environmental Monitoring Program and the Development of its Benthic Biomass Component. Poster Presentation, Calfed Science Conference, Sacramento, CA.

Gehrts, K. and Barnett, R. (2006) Environmental Monitoring Program, Benthic Special Studies. Poster Presentation, National Water Quality Monitoring Conference, San Jose CA.

Waller, S., Gehrts, K., Lehman, P. and Philippart, S. (2005) Microcystis aeruginosa spatial distribution study in San Francisco Bay Estuary. Poster Presentation, IEP Conference, Asilomar, CA.

Lehman, P., Boyer, G., Waller, S. and Gehrts, K. (2005) Biomass and toxicity of the cyanobacteria bloom

of Microcystis aeruginosa in the Delta, October 2003. Poster Presentation, IEP Conference, Asilomar, CA. (in prep)

Gehrts, K., Messer, C., and Vayssières, M. (2005) Proposed 2005-2006 EMP Benthic Special Studies: An Overview. Poster Presentation, IEP Conference, Asilomar, CA. (in prep)

Gehrts, K (2002) The DWR and USBR Environmental Monitoring Program: Small Scale Spatial Variability of Macrobenthos in the Central Delta. Poster Presentation, IEP Conference, Asilomar, CA.

Water Quality Reports: [DWR] Noble, B. (ed.) (2006) Water Quality Conditions in the Sacramento-San Joaquin Delta During 2005. Department of Water Resources, Sacramento, CA. (in prep.)

[DWR] Noble, B. (ed.) (2006) Water Quality Conditions in the Sacramento-San Joaquin Delta During 2004. Department of Water Resources, Sacramento, CA. (in prep.) [DWR] Noble, B. (ed.) (2006) Water Quality Conditions in the Sacramento-San Joaquin Delta During 2003. Department of Water Resources, Sacramento, CA.

[DWR] Giovanni, P. (ed.) (2005) Water Quality Conditions in the Sacramento-San Joaquin Delta During 2001-2002. Department of Water Resources, Sacramento, CA. (in prep)

[DWR] Gehrts, K. (ed.) (2004) Water Quality Conditions in the Sacramento-San Joaquin Delta During 1997-2000. Department of Water Resources, Sacramento, CA.

[DWR] Lehman, P. (ed.) (2001). Water Quality Conditions in the Sacramento-San Joaquin Delta During 1996. Department of Water Resources, Sacramento, CA.

List relevant project/field experience and publications/reports.

Salutation: **Ms**
Last Name: **Peterson**
First Name: **Heather**
Title: **Biologist**
Organization: **USGS**
Position:
primary staff
Responsibilities: **Task 1**
Qualifications:

Curriculum Vitae: Heather A. Peterson

U.S. Geologic Survey Phone: (650) 329 4592 Water Resources Division Fax: (650) 329 4327 345 Middlefield Rd. MS 496 E-mail:hapeters@usgs.gov Menlo Park, CA 94025

Education:

University of California at Davis, B.S., 1993, Resource Science and Management, California State University, San Francisco, M.A., 2002, Marine Biology

Research and Professional Experience:

2003 - present Biologist, U.S. Geological Survey, Menlo Park, CA 2000 - present Environmental Specialist (intermittent), California Department of Water Resources, Sacramento, CA 1998 - 2002 Biological Science Technician, U.S. Geological Survey, Menlo Park, CA 1993 - 1997 Environmental Specialist, California Department of Water Resources, Sacramento, CA 1991 - 1992 Scientific Aid, California Department of Water Resources, Sacramento, CA

Research Interests:

My research interests include, benthic invertebrate ecology, especially in the estuarine environment, with regard to the influence of seasonal and interannual environmental variability as well as exotic species invasions on the function of the benthic assemblage in the estuarine ecosystem.

Relevant Publications:

Peterson, H. A., and M. Vayssières. (2006) Interagency Ecological Program Environmental Monitoring Program; Benthic Monitoring Element 2003-2006 Programmatic Review and Proposed Monitoring Plan. Report to the SWRCB. 78pp. Peterson, H. A., M. Vayssières, and J. K. Thompson. (in prep) Retrospective analysis of historic benthic monitoring data Peterson, H. A., W. Kimmerer, and J. K. Thompson. (in prep) Potamocorbula amurensis, a High-impact Invader in San Francisco Estuary (in prep) Peterson, H. A., and M. Vayssières. (2004) Cross-Channel Variability in Benthic Habitat: Old River. IEP Newsletter Vol. 17 (2) 38-44 (http://www.iep.ca.gov/report/newsletter/2004_newsletters/IEPNewsletter_spring_2004.pdf) M. Vayssières, and H. A. Peterson. (2003) Cross-Channel Variability in Benthic Habitat. IEP Newsletter Vol.16 (2) 51-56 (http://www.iep.ca.gov/report/newsletter/2003spring/IEPnewsletterSpring.pdf) Peterson, H. A. (2002) Long-term Benthic Community Change in a Highly Invaded Estuary. Masters Thesis, Marine Biology. San Francisco State University. San Francisco, CA, USA. 108 pp

Invited and Contributed Talks:

Peterson, H. A., and M. Vayssières. More than one can of worms: 30 years of macrobenthic monitoring in the upper San Francisco Estuary. Invited presentation to the North American Benthological Society, Anchorage Alaska, June 2006.

Peterson, H. A., Science Consensus and Monitoring Strategies: the art of revising a long-term benthic monitoring program. Contributed presentation to the National Water Quality Monitoring Conference, San Jose, CA, May 2006.

Peterson, H. A., Using Long-term benthic Monitoring Data to Inform Restoration. Contributed presentation to the CALFED Science Conference, Sacramento, CA, October 2004.

Awards and Honors:

UC Davis-California Resources Agency Natural Resources Fellow, 1997

List relevant project/field experience and publications/reports.

Salutation: **Dr.**
Last Name: **Vayssieres**
First Name: **Marc**
Title: **Environmental Scientist**
Organization: **DWR**
Position:
secondary staff
Responsibilities: **Task 1 and 3**
Qualifications:

CURRICULUM VITAE

Marc P. VAYSSIERES Department of Water Resources Phone:(916) 651-0154 Division of Environmental Services Email: marcv@water.ca.gov Office of Water Quality 901 P Street Sacramento, CA 95814

EDUCATION 1998 Ph.D., Ecology, University of California, University of California Davis 1993 M.S., Agronomy and Range Science, University of California Davis

POSITIONS 2002 - Present: Environmental Scientist, CA Dept of Water Resources, Division of Environmental Services 2001 Environmental Specialist III, CalFed Bay-Delta Program 1990 - 2000: Research Analyst II (Geographic Information Systems) CA Dept of Water Resources, Division of Environmental Services 1998 - 1999: Environmental Specialist II, Dept of Water Resources, Environmental Services Office.

SELECTED PUBLICATIONS:

Jassby, A.D., Müller-Solger, A.B. and M.P. Vayssières. 2005. Subregions of the Sacramento-San Joaquin Delta: Identification and Use. IEP Newsletter 18(2): 46-56. Peterson, H. and M.P. Vayssières. 2004. Cross-channel Variability in Benthic Habitat: Old River. IEP Newsletter, 17(2): 38-44. Vayssières, M. P. and H. Peterson. 2003. Cross-channel Variability in Benthic Habitat. IEP Newsletter, 16(2): 51-56. Triboli, K., Müller-Solger, A., and M. P.Vayssières. 2003. The Grind about Sonicated Chlorophyll (or:

Did a method change in 1998 affect EMP chlorophyll results?) IEP Newsletter 16(4): 13-25. Vayssières, M. P., R. E. Plant and B. H. Allen-Diaz. 2000. Classification trees: An alternative non-parametric approach for predicting species distributions. Journal of Vegetation Science. 11(5): 679-694. Plant R. E. and M. P. Vayssières. 2000. Combining expert system and GIS technology to implement a state-transition model of oak woodlands. Computers and Electronics in Agriculture. 27(1-3): 71-93. Plant, R. E., M. P. Vayssières, S. E. Greco, M. R. George and T. E. Adams. 1999. A qualitative spatial model of hardwood rangeland state-and-transition vegetation dynamics. Journal of Range Management 52:51-59. Plant, R.E., A. Mermer, G.S. Pettygrove, M.P. Vayssières, J.A. Young, R.O. Miller, L.F. Jackson, R.F. Denison, and K. Phelps. 1999. Factors underlying grain yield spatial variability in three irrigated wheat fields. Transactions of the ASAE 42:1187-1202. Vayssières, M. P. 1998. Physiognomy and spatial structure of California's hardwood rangelands: Recursive partitioning analyses as a basis for state-and-transition models. Ph.D. dissertation, University of California, Davis, CA. USA.

List relevant project/field experience and publications/reports.

Salutation: **Mrs**
Last Name: **Thompson**
First Name: **Janet**
Title: **Reseaerch Scientist**
Organization: **USGS**
Position:
secondary staff
Responsibilities: **Task 1**
Qualifications:

CURRICULUM VITA Janet Kay Thompson U.S. Geological Survey Water Resources Division 345 Middlefield Road MS 496 Menlo Park, California 94025 (650)329-4364 jthompso@usgs.gov

Education • Stanford University, Stanford, California, Ph.D. Civil and Environmental Engineering • California State University, San Francisco, California, M.A. Marine Biology • Lewis and Clark College, Portland, Oregon, B.S. Biology

Experience • 1982-present: Research Scientist, U.S. Geological Survey Menlo Park, California: • 1972: Teaching Assistant, Oregon Institute of Marine Biology, University of Oregon; Lewis and Clark College • 1971: Teaching Assistant, Lewis and Clark College

Research Interest: Ecology and physical dynamics of aquatic systems based on long term (30 year) investigations of the San Francisco Bay and freshwater Delta that has included studies of the following: the coupling between, and interdependence of benthic and pelagic communities; biogeochemical processes related to benthic organism accumulation of natural and anthropogenic elements; the physical dynamics of organic and inorganic particle transfer to the bed; the study of benthic community dynamics in response to natural and anthropogenic stress; and the response of aquatic ecosystems to non-indigenous species.

Highlights: U.S. Department of the Interior, Superior Service Award, 2003 Science Advisory Committees: California Bay/Delta Food Chain Committee-1999-present: California Sea Grant Committee on Exotic Species 1996-present; Interagency Ecological Program Review of Long-term Fish Monitoring Program; CALFED Exotic Species Program 2000-present Editorial Board: Aquatic Nuisance Species Digest (1999-present)

Postdoctorates: Dr. Laurent Chauvaud, Dr. Rene Takesue

Relevant Publications: Carlton, J.T., Thompson, J.K., Schemel, L.E., Nichols, F.H., 1990. Remarkable invasion of San Francisco Bay (California, USA) by the Asian clam Potamocorbula amurensis. I. Introduction and dispersal, Marine Ecology Progress Series, 66, pp. 81-94. Nichols, F.H., Thompson, J.K., Schemel, L.E., 1990. Remarkable invasion of San Francisco Bay (California, USA) by the Asian clam Potamocorbula amurensis. II. Displacement of a former community, Marine Ecology Progress Series, 66, pp. 95-101 Monismith, Stephen G., Koseff, J. R., Thompson Janet K., O'Riordan, Catherine A., and Nepf, Heidi M. 1990. A study of Model Bivalve Siphon Currents: Limnology &Oceanography v. 35, no. 3, p. 680 696 Cole, B.E., J.K. Thompson, and J.E. Cloern. 1992. Measurement of filtration rates by infaunal bivalves in a recirculating flume. Marine Biology, 113: 219-225. Lucas, L.V., J.E. Cloern, J.R. Koseff, S.G. Monismith, and J.K. Thompson. 1998. Does the Sverdrup critical depth model explain bloom dynamics in estuaries? Journal of Marine Research, 56:375-415 Lucas, L.V., J.E. Cloern, J.R. Koseff, S.G.

Monismith, and J.K. Thompson. 1999. Processes governing phytoplankton blooms in estuaries. Part I: The local production-loss balance. Marine Ecology Progress Series v. 187, pp. 1-15 Lucas, L.V., J.E. Cloern, J.R. Koseff, S.G. Monismith, and J.K. Thompson. 1999. Processes governing phytoplankton blooms in estuaries. Part II: The role of horizontal transport. Marine Ecology Progress Series v. 187, pp. 17-30 Thompson, J. K., 1999. The effect of infaunal bivalve grazing on phytoplankton bloom development in South San Francisco Bay, PhD Thesis, Stanford University, Dept. of Civil and Environmental Engineering, Stanford, CA: 419p. Lucas, L.V., J. E. Cloern, J.K. Thompson, and N.E. Monsen. 2002. Functional variability of shallow tidal habitats in the Sacramento-San Joaquin Delta: restoration implications. Ecological Applications 12(5): 1528-1547. Crimaldi, J.P. J.K. Thompson, J.H. Rosman, R. J. Lowe, J. R. Koseff. 2002. Hydrodynamics of larval settlement: The influence of turbulent stress events at potential recruitment sites. Limnology and Oceanography. 47(4):1137-1151 Parchaso, F. and J.K. Thompson, 2002, The influence of hydrologic processes on reproduction of the introduced bivalve Potamocorbula amurensis in Northern San Francisco Bay, California, Pacific Science, 56(3):329-345 Brown, C.L., F. Parchaso, J.K. Thompson, S.N. Luoma. 2003. Assessing toxicant effects in a complex estuary: A case study of effects of silver on reproduction in the bivalve, Potamocorbula amurensis, in San Francisco Bay. Human and Ecological Risk Assessment. 9(1):95-119 Chauvaud, L., J. K. Thompson, J. E. Cloern, and G. Thouzeau. 2003. Clams as CO2 generators: The Potamocorbula amurensis example in San Francisco Bay. Limnology and Oceanography 48(6):2086-2092 Thompson, JK. 2005. One estuary, one invasion, two responses: phytoplankton and benthic community dynamics determine the effect of an estuarine invasive suspension feeder. In: The comparative Roles of Suspension Feeders in Ecosystems, S. Olenin and R. Dame Editors, p. 291-316 Thompson, J.K, J. Koseff, S. Monismith, L. Lucas. Shallow water processes govern system-wide bloom dynamics: II. A field Study. Submitted to J. Marine Systems. Lucas, L., J. Koseff, S. Monismith, J. Thompson. Shallow water processes govern system-wide bloom dynamics: II. A modeling study. Submitted to J. Marine Systems.

List relevant project/field experience and publications/reports.

Conflict Of Interest

This is proposal #0078 for the Science Program 2006 solicitation.

Frequently asked questions and answers for this PSP are now available.

The submission deadline for this proposal has passed. Proposals may not be changed.

Instructions

To assist Science Program staff in managing potential conflicts of interest as part of the review and selection process, we are requesting applicants to provide information on who will directly benefit if your proposal is funded. Please provide the names of individuals who fall in the following categories and are not listed in the Personnel Form:

- Persons 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; and/or
- Subcontractors listed in the proposal, who will perform tasks listed in the proposal, or will benefit financially if the proposal is funded.

Applicant
Submittor
Lead Investigator/Project Director
Primary Staff
Secondary Staff
Subcontractor

Provide the list of names and organizations of all individuals not listed in the proposal who helped with proposal development along with any comments.

Last Name	First Name	Organization	Role

Task And Budget Summary

This is proposal #0078 for the Science Program 2006 solicitation.

Frequently asked questions and answers for this PSP are now available.

The submission deadline for this proposal has passed. Proposals may not be changed.

Instructions

Use the table below to delineate the tasks needed to carry out your proposal. Tasks in this form should support the narrative description of your project in your proposal document and the informa tion provided in your detailed budget spreadsheet. Each task and subtask must have a number, title, timeline, list of personnel or subcontractors providing services, and associated budget figure.

When creating subtasks, ensure that each activity is counted only once. Please note, the initial task of your table (Task 1) must present all project management/administrative activities supporting your overall proposal.

For proposals involving multiple agencies or organizations (including subcontractors), the table must clearly state the tasks and subtasks performed by each entity.

Task #	Task Title	Start Month	End Month	Personnel Involved	Description	Task Budget
1	Project Management, Data Analysis and Reporting	1	24	Messer, Dean	Data analysis, data reporting and publication production will be conducted by K. Gehrts (DWR), H. Peterson (USGS) and Dr. M. Vayssieres (DWR). Dr. J. Thompson (USGS) will provide support. Project management and coordination will be through DWR under the direction of Dr. D. Messer.	140,862
2	Biomass Measurement	1	22	Messer, Dean	Biomass Measurement will be conducted by K. Gehrts, and one Scientific Aid (DWR). Dr. J. Thompson (USGS) will provide methodology and support. As mentioned in the budget justification, staff salaries are the only major expense because lab space and equipment have already been secured with DWR and USGS. Due to the time necessary to sort, identify, count and measure DWR has agreed to pay the salary of the lead environmental scientist, K. Gehrts.	42,000
3	Data Storage and Management	1	24	Messer, Dean	Data Storage and Management will be conducted by Dr. M. Vayssieres, K. Gehrts and one Scientific Aide (DWR).	36,960

total budget=$219,822

Detailed Budget Upload And Justification

This is proposal #0078 for the Science Program 2006 solicitation.

Frequently asked questions and answers for this PSP are now available.

The submission deadline for this proposal has passed. Proposals may not be changed.

Using the budget provided via this link as a guide, please complete a budget for your proposal in the software of your choice (e.g. Excel). This document must be in a format and software that can be converted to PDF prior to uploading on the web system.

It is incumbant upon the applicant to fully explain/justify the significant costs represented in the attached budget. This information can be provided either in a text document and uploaded below, or included in your proposal text in a clearly defined budget justification section. If it is not abundantly clear to reviewers what project costs are commensurate with which efforts and benefits, the proposal may receive a poor review and denied funding.

Costs for each task described in the Task and Budget Summary Form and each staff or subcontractor described on the Contacts and Project Staff Form, must be included in your budget. The budget for Task One should represent project management activities, including but not limited to cost verification, environmental compliance, data handling, report preparation, project oversight, and public outreach. The total amount of your budget must equal the total amount represented on your Task and Budget Summary Form and the total budget amount represented on your Project Information and Executive Summary Form.

In a separate text document to be uploaded below, identify any cost share and other matching funds available to support your proposed project. If you identify cost share or matching funds, you must also describe them in the text of your proposal (see explanation of "cost share and other matching funds" in Section Two of the solicitation document).

CBDA may request additional information pertaining to the items, rates and justification of the information presented in your budget. Applications without completed budgets will not be considered for funding.

Uploading The Completed Budget Template

First, convert your completed Budget to a PDF file. Then, use the browse function to locate the PDF version of your document, select the document and click on the upload prompt below.

You have already uploaded this document. View it to verify that it appears as you expect. You may replace it by uploading another document

Uploading The Completed Budget Justification

First, convert your completed Justification text to a PDF file. Then, use the browse function to locate the PDF version of your document, select the document and click on the upload prompt below.

You have already uploaded this document. View it to verify that it appears as you expect. You may replace it by uploading another document

Uploading The Description Of Cost Share/Matching Funds

First, convert your completed Description of Cost Share/Matching Funds text file to a PDF file. Then, use the browse function to locate the PDF version of your document, select the document and click on the upload prompt below.

You have already uploaded this document. View it to verify that it appears as you expect. You may replace it by uploading another document

Schedule Of Deliverables

This is proposal #0078 for the Science Program 2006 solicitation.

Frequently asked questions and answers for this PSP are now available.

The submission deadline for this proposal has passed. Proposals may not be changed.

Use the table below to delineate the key deliverables and the time necessary to complete them (in months from the date the project's grant agreement is executed). Each Science Program 2006 PSP grant recipient must provide the required minimum deliverables for each project. The required minimum deliverables for each funded proposal are as follows:

- Semi−annual report(s)
- Final Report
- One page project summary for public audience at beginning of project
- One page project summary for public audience upon project completion
- Project closure summary report or copy of draft manuscript
- Presentation at CALFED Science Conference
- Presentations at other events at request of CALFED Science Program staff
- Copy of all published material resulting from the grant

Deliverable	Description	Delivered By: # (In Months From Project Start Date)
Project Summary	One page project summary for public audience - begining	1
First Semi-Annual Report	Progress report	6
Second Semi-Annual Report	Progress report	12
Third Semi-Annual Report	Progress report	18
Final Report	Final Report	24
Project Summary	One page project summary for public audience - completion	24
Project Closure Summary Report	Report summarizing all findings	24
Presentation at CALFED Science Conference	Presentation at CALFED Science Conference	24
Other Presentations	Other presentations as requested by CALFED	24
Copies of All Published Materials	Copies of all published materials delivered to CALFED	24

If you are unable to provide a Schedule of Deliverables as outlined above, please provide your justification of non−compliance in the text box provided below. The Science Program reserves the right to determine a proposal non−eligible based on an applicants inability to provide the materials requested above.

DWR will bear the the full cost of completing and deliverying any document whose due date exceeds the project's timeline.

Letters Of Support Form

This is proposal #0078 for the Science Program 2006 solicitation.

Frequently asked questions and answers for this PSP are now available.

The submission deadline for this proposal has passed. Proposals may not be changed.

Letters Of Support

Should you wish to provide letters of support for your proposed project, you must do so through use of this web form. Letters of support will be provided to independent, panel and public reviewers for reference as part of the overall review process. It is not mandatory to provide letters of support. Failure to do so will in no way affect the review or final determination of your application.

Submission Of These Materials.

To submit Letters of Support, you must do so as .PDF files. To upload these materials, use the browse function to locate the appropriate .PDF version of the documents, select the documents and click on the upload prompt below.

Please ensure your PDF file contains all letters you would like to submit. Individual files (or letters) will not be accepted by the system. The system is designed to receive one single file. Submittal of these documents are not mandatory for your application to be considered under the 2006 Science Program PSP. Failure to submit letters does not impact your ability to compile your proposal along with the supporting forms required for final submission and consideration under the Science Program 2006 PSP.

Letters Of Support *Please upload a PDF version of your letters of support. To upload a document, use the "Browse" button to select the PDF file containing the document.*

Analysis of Archived Samples to Assess Patterns of Historic Invasive Bivalve Biomass

1. Project Purpose

1a. Introduction

Invasive bivalves are considered to be a major sink of primary productivity in the San Francisco Bay - Delta system. Alpine and Cloern (1992) showed that seasonal phytoplankton blooms disappeared after the invasive bivalve *Corbula amurensis* (formerly known as *Potamocorbula amurensis*) invaded the upper San Francisco Estuary. Lucas et al. (2002) found that Sacramento-San Joaquin River Delta habitats where the invasive bivalve *Corbicula fluminea* were abundant were net sinks to phytoplankton biomass. Lopez et al. (2006) concurred with findings that while shallow water habitats in the Sacramento-San Joaquin River Delta could have high phytoplankton productivity, shallow habitats heavily colonized by *Corbicula fluminea* were net sinks of phytoplankton biomass.

Investigations of historic patterns of invasive bivalve population biomass from long-term records will yield information about the relationships between bivalve populations, including benthic grazing pressure and environmental factors, such as hydrologic year type or water management practices. Investigations of small scale spatial variability of invasive bivalve population size structure and biomass within multiple sub habitat types in the San Francisco Bay-Delta system will yield information about the influence of local habitat characteristics on invasive bivalve population density, biomass and grazing potential.

The recently recognized declines in several Delta fish populations have heightened interest in the pelagic food web of the San Francisco Bay-Delta system. Several populations of fish that prey on zooplankton are in decline (*http://www.calwater.ca.gov/DeltaFishPopulations/Enclosure_1.pdf*), with Delta smelt in particular showing signs of starvation (Bennett 2005). Several populations of primary consumers (zooplankton) have declined in recent decades, contemporaneously with the introduction the invasive bivalve *Corbula amurensis* and appear to be food limited (Kimmerer and Orsi 1996, Orsi and Mecum 1996, Mueller-Solger et al 2002). Jassby et al. (2002) report that overall primary production in the Delta is low (70g C m^{-2}) and indicate that primary production lost to invasive bivalve grazing is a key factor in limiting net productivity in the Delta (Jassby et al. 2002).

The work of Lucas et al. (2002) and Lopez et al. (2006) support the concept that bivalve grazing is an important factor in determining overall ecosystem function in the San Francisco Bay-Delta system. Thus, investigations of invasive bivalve population dynamics and grazing pressure over temporal and spatial gradients are important as CALFED considers restoration plans for the system.

Because benthic bivalves are both ubiquitous and abundant in the upper estuary (Carlton et al. 1990, Hymanson 1991, Hymanson et al.1994) and dominant in macrobenthic assemblages (Hymanson et al.1994), accurate estimates of bivalve biomass are necessary for assessment of transfer of not only carbon, but also contaminants among the food webs in this system. Invasive bivalve species have been found to assimilate trace contaminants in this system (Brown and Luoma 1995, Luoma and Linville 1995), and are known to transfer contaminants among trophic levels within the food web (Stewart et al. 2004).

Fortunately, a legacy of environmental monitoring by the Interagency Ecological Program (IEP) Environmental Monitoring Program (EMP) benthic monitoring element in the San Francisco Bay-Delta system has accumulated a wealth of high-quality, archived benthic invertebrate samples with which we may investigate historic bivalve populations. Analysis of patterns of bivalve biomass both over time through a range of hydrologic conditions and over spatial gradients, in several sub-habitats in the San Francisco Bay-Delta System can be conducted on archived historic samples. This study proposes to address changes in invasive bivalve populations over time by analyzing archived samples from monthly or near-monthly monitoring, conducted over a 30 year time period in the lower Sacramento River near Collinsville (IEP EMP sampling site D4-L) and in the lower San Joaquin River system in Old River (IEP EMP sampling site D28A-L), as shown in Figure 1. Assessment of invasive bivalve population patterns over spatial gradients, among major embayments of the Upper San Francisco Estuary and among sub habitats within embayments will be accomplished by analyzing samples that were collected as part of the Small Scale Spatial Variability Study (SSSVS), conducted in Spring and Summer 2005, and which used a probabilistic sampling design to assess the variability of benthic assemblages in 64 ha neighborhoods surrounding several IEP EMP benthic monitoring sites. SSSVS sampling locations include neighborhoods in San Pablo Bay, Carquinez Strait, Suisun Bay, the Lower Sacramento River, Old River, and the lower San Joaquin River, as shown in Figure 2. The distribution of samples within neighborhoods is shown in detail in Figure 3.

1b. Project Goals and Objectives

The objectives of the proposed research project are: (1) to obtain biomass data from benthic samples collected at two long term monitoring sites sampled by the IEP EMP in the San Francisco Bay-Delta system, and for benthic samples collected during an IEP EMP special study of small scale variability in benthic assemblages near six long-term monitoring locations; (2) make these data available to researchers and the public in a useful form; (3) use the data to evaluate trends in the biomass of invasive bivalve species over nearly 30 years, as well as patterns of invasive bivalve biomass over spatial gradients in the upper San Francisco Estuary.

Objective 1: Estimate the biomass (g C m^{-2}) of invasive bivalve species from preserved samples in a non-destructive manner by measuring bivalve shell length and then using a length-to-weight conversion relationship (Benke et al 1999) to estimate bivalve biomass. Length-to-weight relationships for invasive bivalve species *Corbula amurensis* and *Corbicula fluminea* have been developed by USGS over the past two decades and length-to-weight relationships based on this work will be used for our estimates of biomass.

Objective 2: Make data available to researchers and the public in useful form. Biomass data will be stored in the EMP Benthic database and made available for electronic download from the Bay-Delta & Tributaries (BDAT) database web portal. Use of these data by individuals not familiar with the benthic species will be aided by reports and metadata describing our work and the theories behind it, which will be available through the EMP web site on the IEP server, and through deliverables created as a result of this project.

Objective 3: Biomass data summaries will be published in the IEP newsletter and in refereed journal articles if appropriate. Invasive bivalve data will help us explore regional and seasonal changes in benthic influence on the ecosystem processes of the San Francisco Bay-Delta System

1c. Hypotheses

With this proposed study, we will test the following hypotheses:

1. The biomass of invasive bivalves has varied predictably over time in relation to season and hydrographic year type in the lower Sacramento River and in Old River.

2. The mean annual biomass of invasive bivalves at long-term monitoring locations has varied predictably in relation to mean annual outflow flow in the lower Sacramento River and in Old River.
3. The biomass (g C m^{-2}) of invasive bivalve species vary among benthic habitat types (major sub-basins in the upper Estuary) and among sub-habitats (multiple depths, substrate types, distances from shore, or bathymetric features) within major basins in the San Francisco Bay-Delta System.
4. Invasive bivalve biomass data are seasonally divergent from invasive bivalve abundances in the lower Sacramento River and in Old River.

1d. Supporting Information

Ancillary data associated with the archived benthic samples are available from the IEP EMP website (long-term benthic monitoring samples) or are being contributed to this proposed study by participants (SSSVS data are contributed by the IEP EMP).

Length-to-weight relationships for invasive bivalve species in the San Francisco Bay-Delta system have been developed over three decades, by USGS (Jan Thompson, unpublished data). Length-to-weight relationships have been generated for both *Corbula amurensis* and *Corbicula fluminea*. General length-to-weight relationships, developed from all available data for each species will be used except when or where prior studies show that region-specific regressions would be more appropriate.

2. Background and Conceptual Models

Two species of invasive bivalve are dominant in the upper San Francisco Bay-Delta system; *Corbula amurensis*, and *Corbicula fluminea*. *Corbula amurensis* is a native of estuaries from southern China to southern Siberia (Cohen and Carlton 1995). Formerly known as *Potamocorbula amurensis*, it is also sometimes referred to as the 'overbite clam'. *Corbula amurensis* has been both common and abundant in brackish regions of the Upper San Francisco Estuary since soon after its first discovery in the system in 1986 (Hymanson et al 1991, Carleton et al 1990). *Corbula amurensis*, a euryhaline species, is physiologically capable of inhabiting waters with salinity ranges from 2 to 32 psu (Nicolini and Penry 2000), and makes its home in subtidal soft sediments (Carleton et al. 1990).

Corbicula fluminea also known as 'Asian clam' is native to China, Korea, and southeastern Siberia (Ingram, 1948). It is common in subtidal to intertidal sediments of the Delta where waters are fresh (salinity <5 psu) (McMahon 1999). *Corbicula fluminea* is the dominant benthic consumer in the Central Delta (Hymanson et al 1994) and has been an important grazer in ecosystems outside the San Francisco Bay-Delta as well, reducing phytoplankton biomass in other systems, including the Potomac River (Mc Mahon 1999, Cohen et al. 1984, Phelps 1994). Invasive bivalves are common from Delta tributaries (*Corbicula fluminea*) (Leland and Fend 1998) through the confluence of the Sacramento and San Joaquin Rivers (often both species), seaward to San Pablo Bay where Corbula is dominant (Carlton et al. 1990, Hymanson 1991, Hymanson et al. 1994), and southern San Francisco Bay where *Corbula amurensis* and other bivalve species are common.

The seasonal and interannual population dynamics of *Corbula amurensis* and *Corbicula fluminea* have been studied (Peterson 2002, Lucas et al. 2002, Lopez et al. 2006). These analyses show that population's size, in terms of local abundance, can fluctuate by several orders of magnitude over time and spatial gradients. *Corbula amurensis* population maxima can shift among sub-basins in the Upper Estuary in different hydrologic year types (Peterson in prep). Several studies show that when bivalve populations are high, phytoplankton concentrations are low (Cloern 1982, Alpine and Cloern 1992, Lucas et al 2002, Lopez et al 2006).

Because clams can vary over orders of magnitude in somatic size (and thus feeding capacity), measurements biomass in a sampled population are a better measure of ecological function than population counts or abundance (Peterson 2002). It is clear from preliminary data (developed by a similar project conducted with CALFED funding) that there is not a 1:1 relationship between organism abundance and biomass (g C m^{-2}) for invasive bivalves. Figure 4 shows count and biomass data for *Corbula amurensis* from Grizzly Bay. The plot shows a clear divergence between biomass and count data, especially in the fall of dry years. Preliminary data generated under the auspices of a pilot study funded by the IEP Pelagic Organism Decline (POD) research effort, from historic samples from the lower Sacramento River (Figure 5) show that both *Corbula amurensis* and *Corbicula fluminea* are present at this location (IEP EMP site D4), that trends of abundance biomass are dissimilar and that there is not a one-to-one relationship between abundance and biomass at this site.

With a complete set of data from the lower Sacramento River site and from the site in Old River (where only *Corbicula fluminea* are found) we will be able to discern patterns of biomass for invasive bivalve species, and thus assess trends in benthic grazing pressure over time.

Prior studies have found that invasive bivalve population structure can be patchy in nature (Lopez et al (2006) found that *Corbicula fluminea* was patchy and biomass varied from 0 to 130 g dw m^{-2}). Likewise, *Corbula amurensis* populations often have a patchy distribution (Peterson in prep). Preliminary analyses of small scale spatial variability in benthic assemblages shows that local variability in the benthic species assemblage tends to be greatest where bathymetry is most variable. We anticipate invasive bivalve populations will vary somewhat predictably with physical habitat variables. Analyses to determine which variables are best correlated with invasive bivalve populations will be helpful to habitat restoration efforts in the future.

2a. Conceptual Models

Phytoplankton biomass can be controlled by benthic grazers (Cloern 1982, Lucas et al 1999a, b, Thompson 1999). The presence of invasive species can act as overriding controls of habitat function, adding uncertainty to management outcomes (Lopez et al 2006). Consumption of phytoplankton biomass by the invasive clam *Corbicula fluminea* was an important control on phytoplankton growth rates in the Sacramento San Joaquin Delta (Lopez et al 2006). *Corbicula* grazing rates were, on average, eight times higher than zooplankton grazing in colonized habitats (Lopez et al. 2006). Phytoplankton biomass and production were consistently low in habitats colonized by *Corbicula fluminea*, such that colonized habitats were not only net sinks for phytoplankton, but could contribute to a net phytoplankton deficit in neighboring deep habitats where zooplankton could feed (Lopez et al. 2006). These findings clearly indicate that *Corbicula fluminea* colonization will determine a habitat's value to the pelagic food web.

Environmental variability and anthropogenic water management practices affect physical and biological conditions throughout the San Francisco Bay-Delta system, thus affecting the distribution, abundance, growth, and ultimately standing-stock or biomass of benthic invertebrates, including invasive bivalves. Many benthic invertebrates rely on temperature cues to stimulate transitions between life stages (Ruppert and Barnes 1994). Alterations in flows through the Bay-Delta system can change seasonal temperature patterns, and thus bring changes in the timing of development, or the onset of spawning. Changes in flow patterns, due to variability in natural runoff, and/or water management operations can alter the dispersal of pelagic life stages, the distribution of food, and the geographic distribution of salinity within the Estuary which would then alter the spatial distributions of invasive bivalve species populations, change somatic condition (i.e. somatic size or amount of

stored energy) of bivalve populations and likely change the size structure of bivalve populations in the estuary. Measurements of size frequency distribution and estimated biomass within populations of invasive bivalves over time will allow us to assess factors which influence the population biomass, and thus grazing potential and potential to transfer contaminant material from the benthos into other portions of the food web in this system (Figure 6).

2b. Physical Setting

Figures 1-3 show the physical locations where historic samples for this proposed analysis were historic samples have been collected. Station D4 is located in the lower Sacramento River, near its confluence with the San Joaquin River (Figure 1). While this site is generally riverine in nature, it can become home to euryhaline organisms during periods of prolonged low Delta outflow, such as the 1986-1992 drought. Station D28A is located in the Old River, in the lower San Joaquin River system (Figure 1). It is generally riverine in nature. Sites sampled for the Small Scale Spatial Variability Study (SSSVS) are located in major sub-basins of the Upper San Francisco Estuary, including the shallows of San Pablo Bay (site D41A and neighborhood), the channel of Carquinez Strait (D6 and neighborhood), the shallows of Grizzly Bay (D7 and neighborhood), the channel of the lower Sacramento River (D4 and neighborhood), Old River (D28A and neighborhood), and the channel of the lower San Joaquin River near Stockton (P8 and neighborhood) (Figure 2). In neighborhoods situated in broad embayments 30 samples were randomly distributed within a 800m by 800m (64ha total area) square region (Figure 3). In channel areas the neighborhood shape was constrained by the channel banks, but the neighborhood stretched to cover a 64 ha wetted region (Figure 3).

3. Approach and Scope of Work

3a. Approach

This project proposes to measure bivalves from one sample per-month for all available months at two of the longest-term monitoring sites sampled by the IEP EMP (D4 and D28A). Site D4-L is located in the lower Sacramento River near Collinsville, close to the confluence of the Sacramento and San Joaquin Rivers, and has been consistently sampled monthly or near-monthly since October 1975. Site D28A-L is located in Old River, which is a portion of the lower San Joaquin

River system, and been consistently sampled monthly or near-monthly since June 1977. Locations of the two long-term monitoring sites are shown in Figure 1.

Bivalves occurring in samples taken during the Small Scale Spatial Variability Study (SSSVS), conducted in April and July, 2005, and discussed above, will also be measured. The SSSVS sampling locations include neighborhoods in San Pablo Bay, Carquinez Strait, Suisun Bay, the Lower Sacramento River, Old River, and the lower San Joaquin River, as shown in Figure 2. The distribution of samples within neighborhoods is shown in detail in Figure 3.

Computations of the biomass of invasive bivalve species found in each sample will be accomplished using species-specific length-to-weight equations that have been developed over many bivalve studies in the San Francisco Bay-Delta system. Length-to-weight equations have been developed through ashing (to measure ash-free dry weight) for invasive bivalve species in this system for the past two decades, and the equations derived from this length-to-weight analyses will be provided by Jan Thompson (USGS). Species-specific biomass values will be reported in gC m^{-2}. For long-term records, time series of invasive bivalve biomass will be compiled for further analysis with existing abiotic (hydrographic, physico-chemical, and substrate) data as well as biotic (benthic assemblage, phytoplankton, and zooplankton) data. Species-specific invasive bivalve biomass values from the SSSVS samples will be used with spatial coordinates from the samples, ancillary physical habitat data (depth, sediment type, bathymetric setting, channel location), and biological data (benthic assemblage) to analyze trends in biomass over physical and biological gradients.

Size frequency and biomass data will be stored on the Bay Delta and Tributaries (BDAT) data server (http://bdat.ca.gov/), where it will be publicly available for download. Meta data and reports of the data analyses will be hosted on the IEP EMP website (http://www.iep.ca.gov/emp/), which is also open to the public.

3b. Methods Techniques and Equipment, Data Collection, Statistical Analyses, Quality Assurance and Separation of Tasks

Task 1– Project Management, Data Analysis and Reporting

The project manager will ensure that all listed products and deliverables are completed within the project timeline. Quarterly reports and a final report will be submitted to CALFED by the project manager. The quarterly reports will contain relevant information regarding the status of project tasks.

The final report will integrate the results of tasks 1 through 3 and present the project findings in a technical format. All administrative, contracting and budget maintenance tasks will be carried out under the auspices of the DWR.

Benthic macrofaunal biomass estimates: The analyses of biomass data will include identifying and describing large scale and small scale spatial patterns of biomass within the upper San Francisco Estuary. We will also characterize long term trends in biomass at the 2 EMP sites. Seasonal and inter annual trends in biomass will be reported by site and by species. Biomass trends will be related to environmental variables (e.g. conductivity, freshwater flow rate, phytoplankton biomass, etc.), CVP and SWP operations, and invasive species chronologies. These analyses will build upon and greatly improve the results of an ongoing retrospective analysis of the EMP benthic monitoring data that was partially funded by the CALFED science program. This retrospective analysis objectives are: identifying recurring taxa assemblages within the benthic community at core EMP benthic monitoring sites; determining the predictable relationships between taxa assemblages and environmental conditions and/or species invasions; describing community function over the course of the historical sampling period using the results of taxa assemblage analyses and published records of species natural histories and functional characteristics. Importantly, benthic bivalve biomass estimates will greatly improve our ability to determine where and when benthic assemblages were capable of having significant effects on bio-geo-chemical cycling of nutrients and trace elements (e.g., where and when have filter-feeders have been abundant enough to limit food to other populations, and where and when changes in benthic assemblages might have affected trace element transport or patterns of predation for higher trophic levels). We will identify and describe spatial patterns of benthic biomass within the upper Estuary. Biomass patterns will be related to patterns of environmental variables (e.g. conductivity, temperature, bathymetry, flow rate, phytoplankton biomass, and sediment characteristics).

Information dissemination: Two methods will be used to disseminate the biomass data and species information acquired during this project. First, we will work with BDAT staff to make weight measurements and population notes data available for download in tabular form from the BDAT portal. Secondly, methodological information such as the conversion coefficients used for each species will be included in the benthic program element's metadata pages on the EMP web site.

All researchers place high value on regular peer-reviewed publication of results and sharing of information and ideas at conferences. This proposed program will prepare one or more scientific papers for peer-reviewed journals. One or more members of the team will also present their results annually at either the State of the Estuary or the CALFED Science conference. Lastly, the EMP website will display reports, publications by project members, documents, and related links.

Task 2 - Biomass Measurement

Estimating biomass: Our method of estimating biomass will be as follows:

(1) Measure the shell length (longest axis) of each *Corbula amurensis* and *Corbicula fluminea* found in each sample. Measurements, to the nearest millimeter in shell length will be made using one of three methods a) measurement using ocular micrometer on a dissecting microscope, b) measurement using calibrated digital image analysis software, or c) measurement with hand-held Vernier calipers. While species have been archived separately in recent samples, some historic samples require species pre-sorting, before bivalves can be measured. For all samples, the number of bivalves found in the archived sample material will be compared to bivalve counts from the original samples analysis – to verify that all animals in the sample are accounted for in the measuring. Once clams are measured, the number of measurements is again checked against the number of clams in the sample. Measurements of objects of known size are used to calibrate bivalve measuring devices at least daily. When the digital image analyzer is used for measuring bivalves, calibration measurements are made each time the instrument is adjusted. Visual inspection of the data and the bivalve sample material are made before the data are recorded.

(2) Convert bivalve shell-length measurements to tissue dry weight using length-to weight conversion equations;

(3) Convert dry tissue weight to carbon equivalent (g C m^{-2});

(4) Sum species biomass values for each sample;

(5) Estimate error of biomass values.

Estimation error: Several factors may introduce error into these estimates and an error analysis of the data (Bevington and Robinson 1992) will include the following factors. First, the error associated with benthic sampling can be substantial due to the patchy nature of benthic communities. Some error can be expected to propagate from poorly archived samples with disintegrating shells, which are difficult to measure accurately though care will be taken to get the most representative measurements possible for each sample. Additional checks on the wet weight to dry weight conversions will be available for two of the bivalves (*Corbula. amurensis* and *Corbicula. fluminea*) which have been measured, and converted to dry

weight by use of length to tissue weight regressions (unpublished data, Thompson USGS). There can be seasonal and regional patterns in length-to-weight relationships for bivalves. Where regional and seasonal differences in length to tissue weight regressions are known, regressions sensitive to the regional bias will be used.

Samples to be measured: We have selected samples from two sources which will yield complementary information on changes in invasive bivalve biomass. Samples with high temporal resolution are drawn from 2 EMP long-term benthic monitoring stations (D4 and D28A). One sample from each (mostly monthly) sampling event from 1975 - Sept 2006 will be measured. Samples with high spatial resolution are drawn from the SSSVS, a special study conducted in spring and summer, 2005, which collected a total of 360 samples.

Task 3 - Data Storage and Management

The EMP currently maintains a relational database to store and manage its benthic element's data. This database contains the entire EMP benthic macro invertebrate monitoring dataset from 1975 to the present. It also stores sediment data acquired in conjunction with the benthic sampling. Data from special studies such as the SSSVS are now also stored in this database. Metadata are available from the EMP web site (*http://iep.water.ca.gov/emp/*). Once data have been reviewed for accuracy (and published in the case of special studies), they are exported electronically to the IEP Bay-Delta & Tributaries Project (BDAT) servers and are publicly available through the BDAT data portal (*http://baydelta.ca.gov*). We will modify the structure of the EMP Benthic database to allow for the storage of the bivalve measurements and biomass estimates acquired during this project, and work with BDAT staff to make weight measurements and population notes data available for download in tabular form from the BDAT portal.

4. Feasibility

4a. Project Feasibility

The proposed project is a continuation of research efforts that have been successfully conducted by the collaborators in the past. The sample material has already been collected, which is a major cost savings as no new samples need to be collected. No permits are needed. All laboratory space and equipment have been secured (at no additional cost). The methods that are proposed to be

used for measuring bivalve samples, compiling size frequency distributions, and estimating biomass have been successfully used by contributing authors (Jan Thompson) in previous studies. The staff has already been trained. Salaries for several of the collaborators will be covered by current agency budgets and these salaries are not budgeted within this project.

4c. Project Completability

The project team consists of individuals in institutions, agencies and companies uniquely qualified for this research. This project combines the experience and expertise of staff and researchers at DWR and USGS. Researchers at USGS have gained an increasing amount of knowledge of processes and interactions in the benthic community of the San Francisco Estuary. The DWR has conducted research and monitored the San Francisco Estuary since 1975, providing major insight into the effects of water project operations, introduction of invasive species and other natural stressors on the San Francisco Estuary ecosystem. Personnel on this team have been involved in long-term monitoring of the delta and the estuary by DWR and USGS. Curricula vitae for key staff have been entered into the CALFED PSP website

4c. Project Management, Coordination and Cost Sharing

This project will be a collaborative effort between the California Department of Water Resources (DWR) and the United States Geological Survey (USGS).

Task 1 (Project Management, Data Analysis and Reporting) data analysis, data reporting and publication production will be conducted by K. Gehrts (DWR), H. Peterson (USGS) and Dr. M. Vayssieres (DWR). Dr. J. Thompson (USGS) will provide support. Project management and coordination will be through DWR under the direction of Dr. D. Messer.

Task 2 (Biomass Measurement) will be conducted by K. Gehrts, and one Scientific Aid (DWR). Dr. J. Thompson (USGS) will provide methodology and support. As mentioned in the budget justification, staff salaries are the only major expense because lab space and equipment have already been secured with DWR and USGS. Due to the time necessary to sort, identify, count and measure DWR has agreed to pay the salary of the lead environmental scientist, K. Gehrts.

Task 3 (Data Storage and Management) will be conducted by Dr. M. Vayssieres, K. Gehrts and one Scientific Aide (DWR).

5. Relevance to CALFED Science Program

5a. Relevance to This PSP

These analyses will provide information to aid in analysis of uncertainty regarding the effect of bivalves in restored habitat by assessing patterns of invasive bivalve biomass. The analyses proposed for this project address abiotic (temperature, salinity, depth, flow, turbidity, and contaminants), and biotic (natural population cycles, response to other invasives, competitors, predators, etc.) factors that have been associated with fluctuations in bivalve biomass characteristics in the past (Topic 2).

Trends and patterns of populations and system response to a changing environment (Topic 3) will also be assesses by this project. Assessment of historical samples with excellent temporal and spatial resolution will help CALFED address how invasive bivalve populations and their effects might respond to present and future dynamics of populations of key species, system operations and anticipated environmental changes based on patterns seen in historic samples. This study will discuss the implications for management strategies of the species responses seen over time and space in the system and discuss models that are needed to describe driver/response relationship

Assessment of patterns of invasive bivalve biomass in the San Francisco Bay-Delta system will also help inform projections of the extent and quality of Delta habitat for key species, especially with regard to the affects of invasive species (Topic 4), and how future scenarios will be affected by biotic drivers.

5b. Relevance to Other CALFED Priorities

CALFED wishes to improve ecosystem quality by increasing habitats and improving ecological functions in the Bay-Delta system to support sustainable populations of diverse and valuable plant and animal species, and understanding the dynamics of invasive bivalve populations, which can clearly affect the trophic cascade in aquatic habitats (Lucas et al. 2002, Lopez et al. 2006) is a key step in successful habitat development. CALFED is charged with ensuring public involvement and outreach, and coordinating and integrating related government programs, and this proposed interagency project teams local experts to produce data and analyses that will be readily available to the public. One of CALFED's goals is to establish a body of knowledge relevant to CALFED actions and their implications, including effects on key San Francisco Bay-Delta system

elements such as primary productivity, transfer of toxic trace elements, and general food web effects, which can be communicated to the scientific community, CALFED stakeholders, and the public. This proposed project will provide data and analysis to the public in the form of downloadable data, documentation and peer-reviewed analyses.

CALFED has explicitly stated that it will not fund routine monitoring or mandated projects. This proposed project will use sample material historically collected under the auspices of a mandated monitoring program, but this project stands on its own, separate from the mandated IEP EMP monitoring mission. The analysis of historically collected sample material to answer specific questions about spatial and temporal patterns of invasive bivalve biomass gives us a unique opportunity to fundamentally advance the understanding of the complex San Francisco Bay-Delta system.

6. Qualifications

see Contacts and Project Staff Form

7: Literature Cited

Alpine AE, Cloern JE (1992) Trophic interactions and direct physical effects control phytoplankton biomass and production in an estuary. Limnol Oceanogr 37:946-955

Benke AC, Huryn AD, Smock LA, and JB Wallace (1999) Length-mass relationships for freshwater macroinvertebrates in North America with particular reference to the southeast United States. J. N. Amer. Benthol. Soc. 18: 308-343

Bennett WA (2005) Critical Assessment of the Delta Smelt Population in the San Francisco Estuary, California. San Francisco Estuary and Watershed Science. 3 (2)

Bevington and Robinson (1992) Data Reduction and Error Analysis for the Physical Sciences, Second Edition, McGraw-Hill, Inc., New York.

Brown CL, Luoma SN (1995) Use of the euryhaline bivalve *Potamocorbula amurensis* as a biosentinel species to assess trace metal contamination in San Francisco Bay. Marine Ecology Progress Series 124:129-142

Carlton JT, Thompson JK, Schemel LE, Nichols FH (1990) Remarkable invasion of San Francisco Bay (California, USA) by the Asian clam *Potamocorbula amurensis*. I. Introduction and dispersal. Marine Ecology Progress Series 66:81-94

Cloern JE (1982) Does the Benthos Control Phytoplankton Biomass in South San Francisco Bay? Marine Ecology Progress Series 9:191-202

Cohen AN, Carlton JT (1995) Nonindigenous Aquatic Species in a United States Estuary: A case study of the biological invasions of the San Francisco Bay and Delta. Report No. Report No. PB96-166525, United States Fish and Wildlife Service, Washington D. C.

Cohen RRH, Dresler PV, Phillips EJP, Cory RL (1984) The effect of Asiatic clam, *Corbicula fluminea*, on phytoplankton of the Potomac River, Maryland. Limnol Oceanogr 29:170-180

Hymanson Z (1991) Results of a Spatially Intensive Survey for *Potamocorbula amurensis* in the upper San Francisco Bay Estuary. Report No. 30, Interagency Ecological Studies Program for the Sacramento-San Joaquin Estuary, Sacramento, CA

Hymanson Z, Mayer D, Steinbeck J (1994) Long-term trends in benthos abundance and persistence in the upper Sacramento-San Joaquin Estuary: Summary report 1980-1990. Report No. 38, Interagency Ecological Program for the San Francisco Bay/Delta Estuary

Ingram WM (1948) The large freshwater clams of California, Oregon, and Washington. J. Entomol. Zool. 40(4):72-92.

Jassby AD, Cloern JE, Cole BE (2002) Annual primary production: Patterns and mechanisms of change in a nutrient-rich tidal ecosystem. Limnol Oceanogr 47:698-712

Kimmerer WJ, Orsi JJ (1996) Changes in the zooplankton of the San Francisco Bay Estuary since the introduction of the clam *Potamocorbula amurensis*. In: Hollibaugh JT (ed) San Francisco Bay the ecosystem. Pacific Division of the American Association for the Advancement of Science, San Francisco, p 542pp

Leland HV, Fend SV (1998) Benthic invertebrate distributions in the San Joaquin River, California, in relation to physical and chemical factors. Canadian Journal of Fisheries and Aquatic Science 55:1051-1067

Lopez CB, Cloern JE, Schraga TS, Little AJ, Lucas LV, Thompson JK, Burau JR (2006) Ecological Values of Shallow-Water Habitats: Implications for the Restoration of Disturbed Ecosystems. Ecosystems 9:422-440

Lucas, L.V., Koseff, J.R., Cloern, J.E., Monismith, S.G., and Thompson, J.K.(1999) *Processes governing phytoplankton blooms in estuaries, I, the local production-loss balance*: Marine Ecology Progress Series, v. 187, p. 1-15.

Lucas, L.V., Koseff, J.R., Monismith, S.G., Cloern, J.E., and Thompson, J.K. (1999) *Processes governing phytoplankton blooms in estuaries, II, the role of horizontal transport:* Marine Ecology Progress Series, v. 187, p. 17-30.

Lucas LV, Cloern JE, Thompson JK, Monsen NE (2002) Functional variability of habitats within the Sacramento-San Joaquin Delta: restoration implications. Ecological Applications 12:1528-1547

Luoma SN and R Linville (1995) A Comparison of Selenium and Mercury Concentrations in Transplanted and Resident Bivalves from North San Francisco Bay. Regional Monitoring Program for Trace Substances, 1995 Annual Report, SFEI Publications 160-170.

Orsi JJ, Mecum WL (1996) Food Limitation as the Probable Cause of a Long-term Decline in the Abundance of *Neomysis mercedes* the Opossum Shrimp in the Sacramento-San Joaquin Estuary. In: Hollibaugh JT (ed). AAAS, p 375-401

McMahon RF (1999) Invasive Characteristics of the Freshwater Bivalve Corbicula fluminea. In: Claudi R, Leach JH (eds) Nonindigenous Freshwater Organisms: vectors, biology, and impacts. Lewis Publishers, Boca Raton, Fl., p 315-343

Muller-Solger, A., Jassby, A., and Muller-Navarra, D., 2002. Nutritional Quality of Food Resources for Zooplankton (Daphina) in a Tidal Freshwater System (Sacramento-San Joaquin River Delta). Limnol. Oceanogr., 47 (5): 1468-1476.

Nicolini, M. H. and D. L. Penry (2000). "Spawning, fertilization, and larval development of *Potamocorbula amurensis* (Mollusca: Bivalvia) from San Francisco Bay, California." Pacific Science **54**(4): 377-388.

Peterson, H. A. (2002). Long-term Benthic Community Change in a Highly Invaded Estuary. Master's Thesis. California State University, San Francisco. San Francisco CA, USA. 108pp.

Peterson, H. A. (in prep) Results of the 1995 Spatially Intensive Survey for *Corbula amurensis*. IEP technical report.

Phelps, H. L. (1994). "The Asiatic clam (Corbicula fluminea) invasion and system level ecological change in the Potomac River Estuary near Washington D.C." Estuaries **17**(3): 614-621.

Ruppert EE, Barns RD (1994) Invertebrate Zoology, Vol. Saunders College Publishing, New York

Stewart AR, Luoma SN, Schlekat CE, MDoblin MA, Hieb K (2004) Food Web Pathway Determines How Selenium Affect Aquatic Ecosystems: A San Francisco Bay Case Study. Environmental Science and technology 38:4519-4526

Thompson, J.K., 1999, The effect of infaunal bivalve grazing on phytoplankton bloom development in south San Francisco Bay: Stanford University, Stanford, Calif., Ph.D. dissertation, 419 p.

8: Figures and Tables

Figure 1. Map of IEP EMP benthic monitoring stations to be analyzed for this study (D4-L, D28A-L)

Station D4 is located in the lower Sacramento River, near its confluence with the San Joaquin River. While this site is generally riverine in nature, it can become home to euryhaline organisms during periods of prolonged low Delta outflow, such as the 1986-1992 drought. Station D28A is located in the Old River, in the lower San Joaquin River system. It is generally riverine in nature.

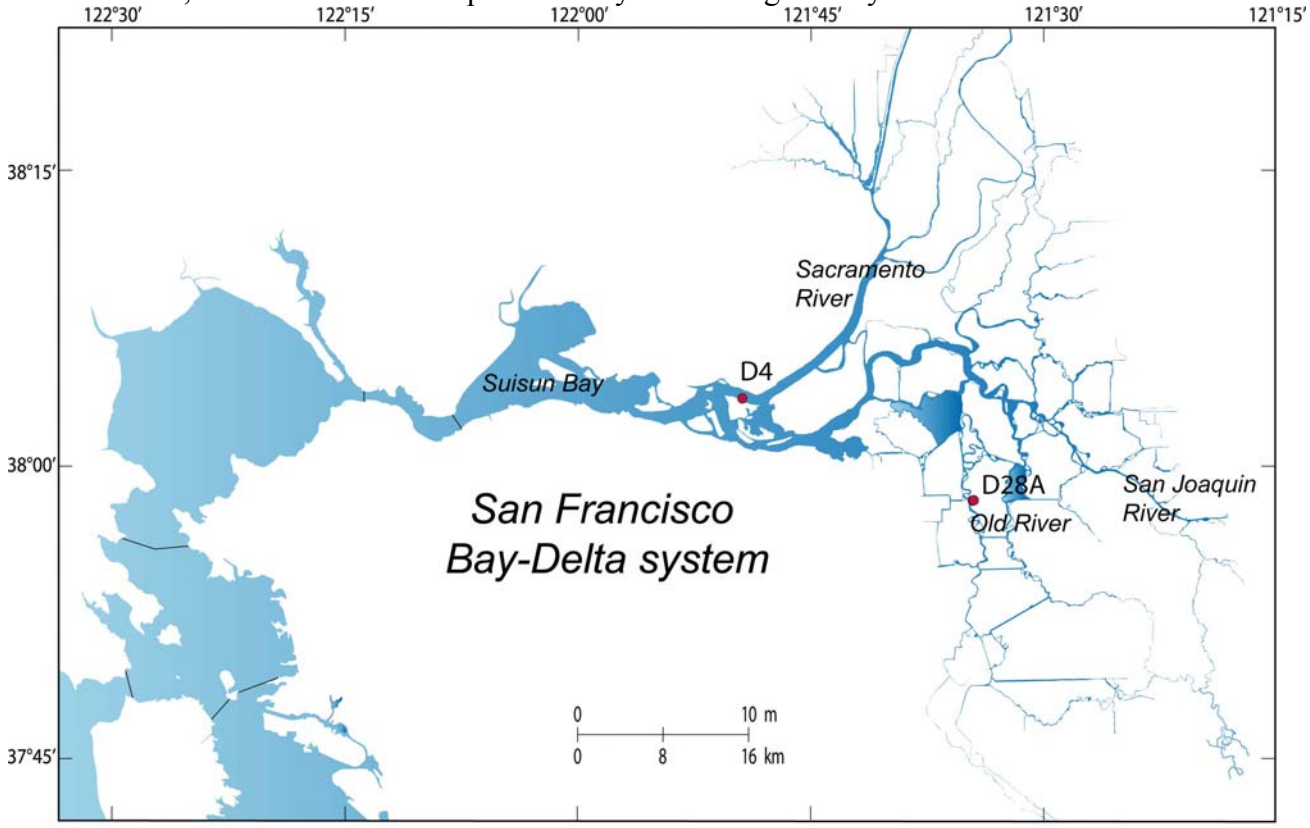


Figure 2. Map of SSSVS sites in the Upper Estuary

Sites sampled for the Small Scale Spatial Variability Study (SSSVS) are located in major sub-basins of the Upper San Francisco Estuary, including the shallows of San Pablo Bay (site D41A and neighborhood), the channel of Carquinez Strait (D6 and neighborhood), the shallows of Grizzly Bay (D7 and neighborhood), the channel of the lower Sacramento River (D4 and neighborhood), Old River (D28A and neighborhood), and the channel of the lower San Joaquin River near Stockton (P8 and neighborhood).

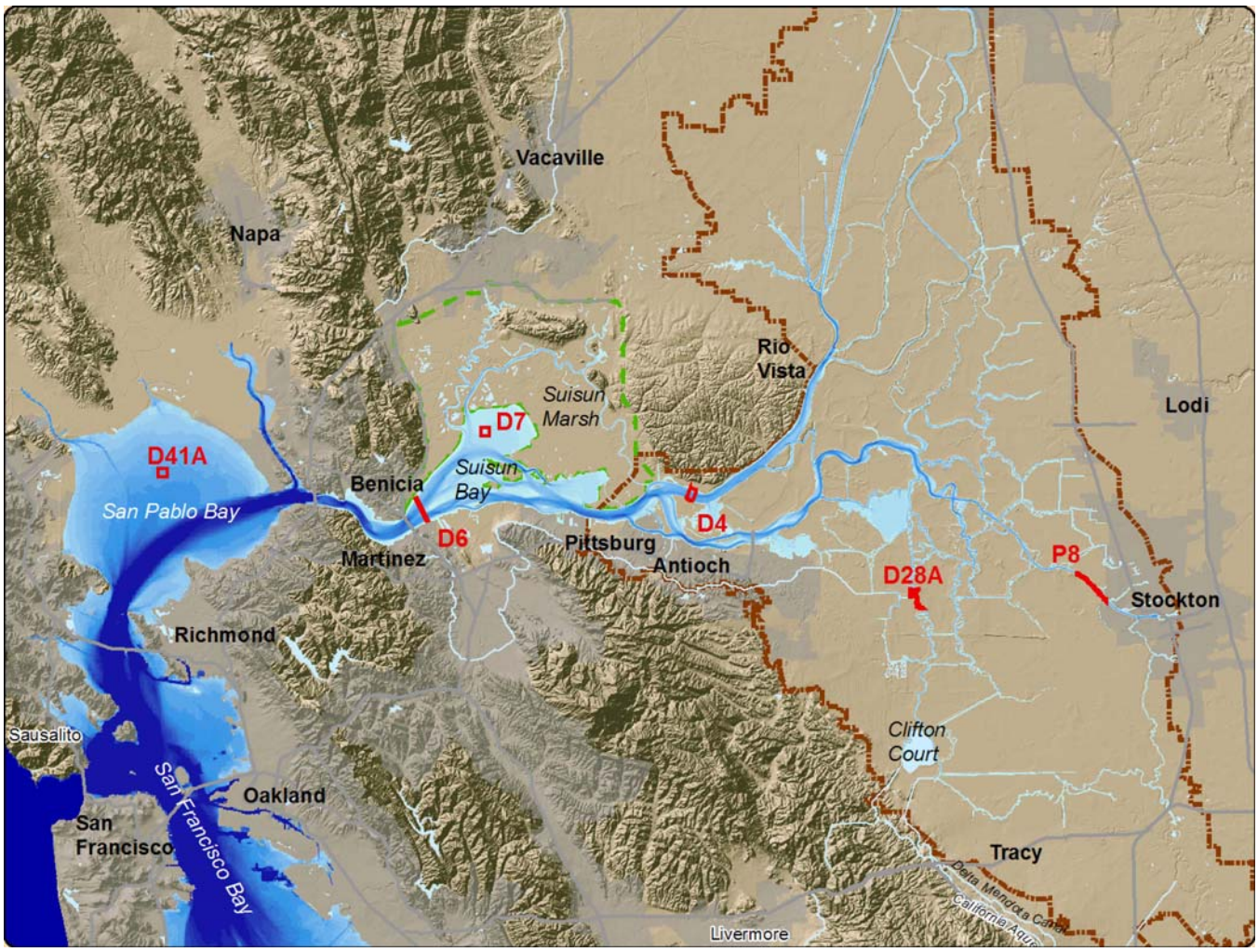


Figure 3. Arrangement of probabilistic sampling locations neighborhoods
The arrangement of sampling locations in the D4 and neighborhood in the channel of the lower Sacramento River (A) and the D28A and neighborhood, in Old River (B) are shown. In neighborhoods situated in broad embayments 30 samples were randomly distributed within a 800m by 800m (64ha total area) square region. In channel areas the neighborhood shape was constrained by the channel banks, but the neighborhood stretched to cover a 64 ha wetted region. Both neighborhoods shown are in constrained channel areas.

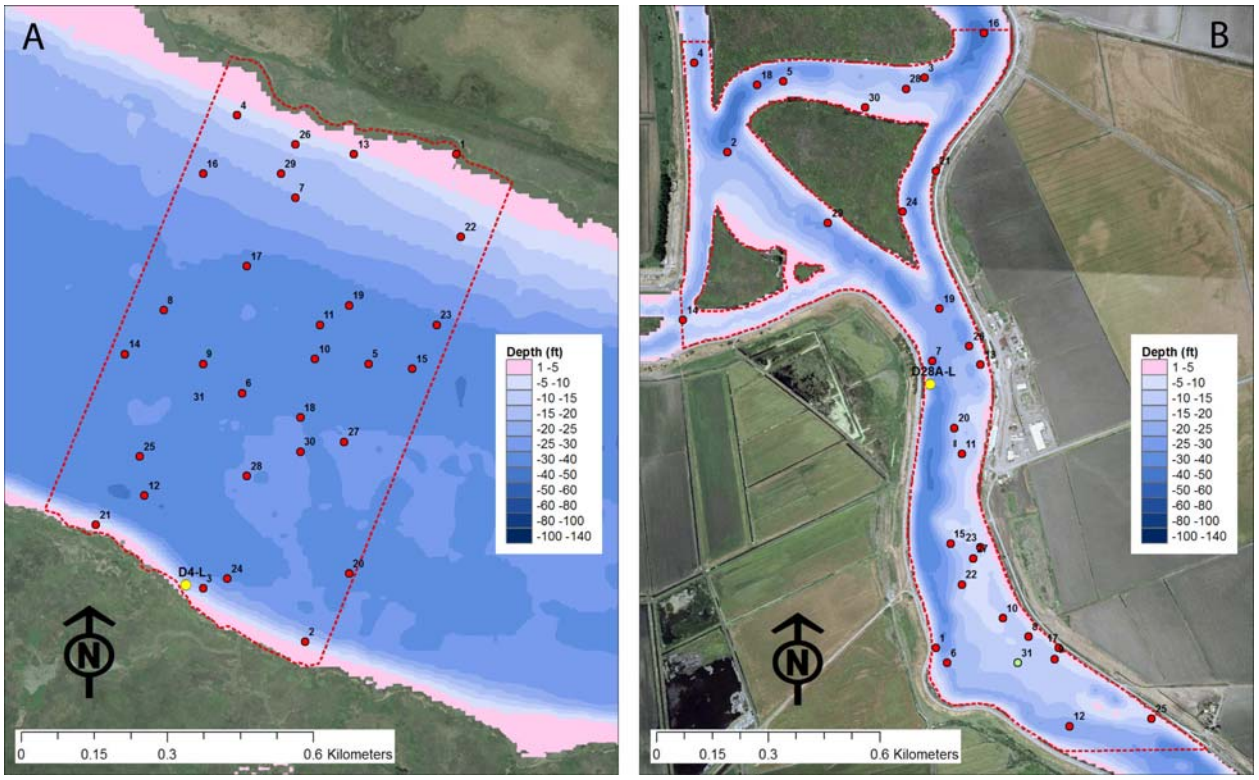


Figure 4. Comparison of *Corbula amurensis* abundance and biomass m^{-2} in Grizzly Bay (IEP EMP monitoring site D7) 1987-2006

Count and biomass data for invasive bivalve *Corbula amurensis* from Grizzly Bay are shown. The plot shows a clear divergence between biomass and count data, especially in the fall of dry years.

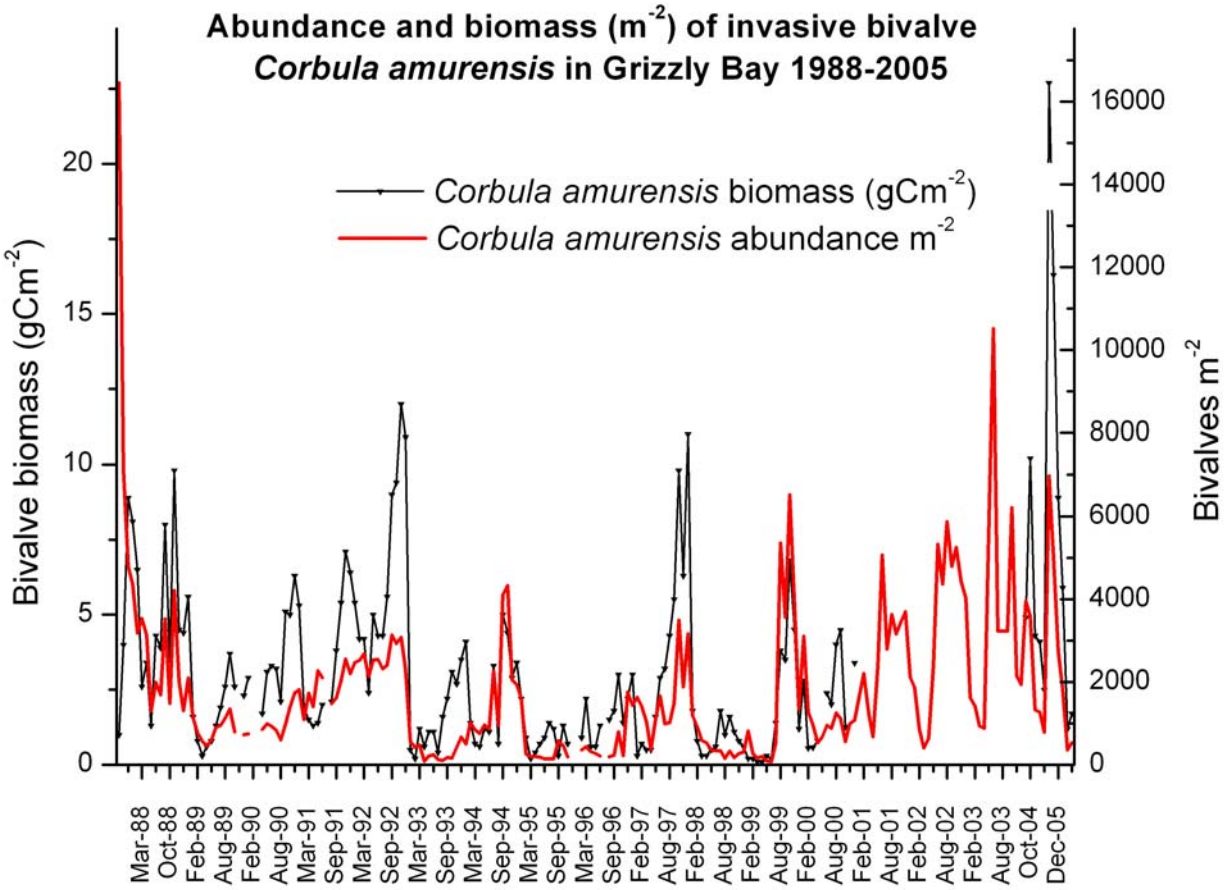


Figure 5. Comparison of *Corbula amurensis* and *Corbicula fluminea* abundance and biomass m^{-2} in the lower Sacramento River (IEP EMP monitoring site D4) using sample data from 1991, 1998, 2000, 2002, 2004, 2005, and 2006.

Both of the dominant invasive bivalve species, *Corbula amurensis* and *Corbicula fluminea,* are present at this location (IEP EMP site D4). Trends of bivalve abundance biomass are dissimilar and there is not a one-to-one relationship between abundance and biomass at this site. Plotted data are from preliminary data developed under the auspices of a pilot study funded by the IEP Pelagic Organism Decline (POD) research effort.

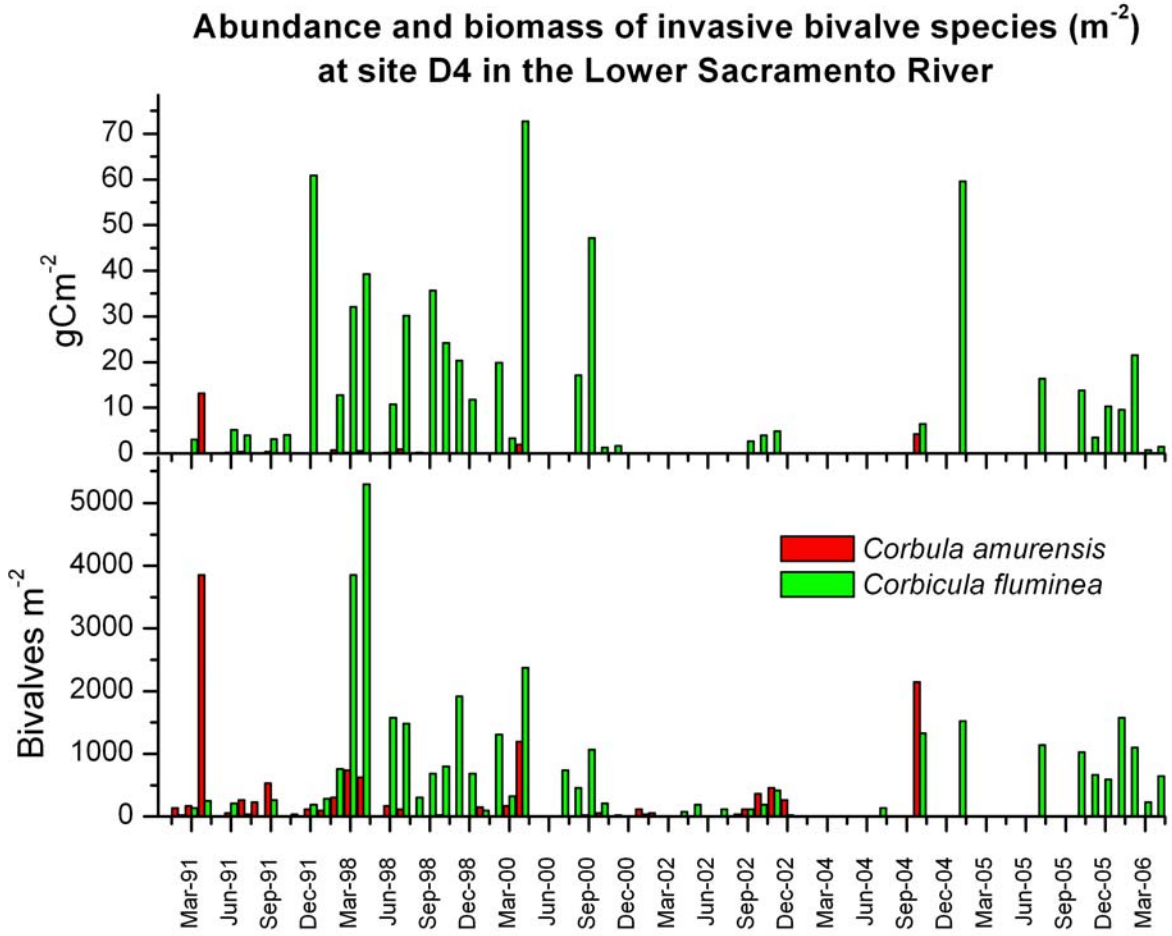
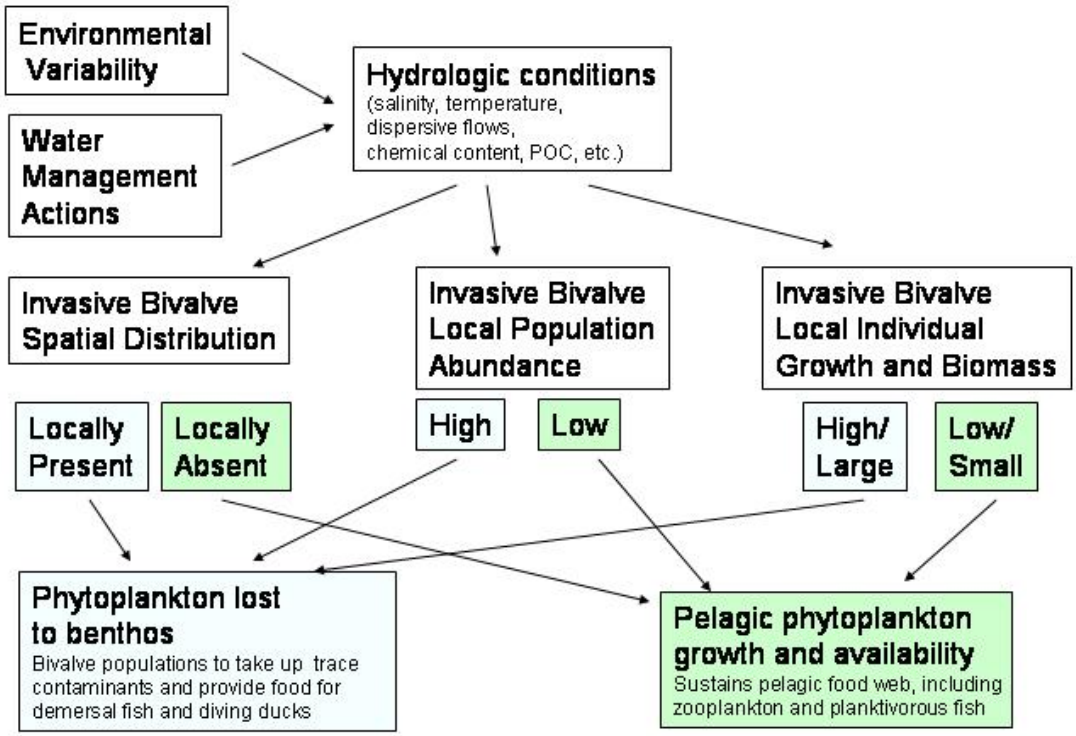


Figure 6. Conceptual Model of interactions between hydrologic conditions, invasive bivalves, and habitat function

Environmental variability and water management actions influence hydrologic conditions in the estuary. Hydrologic conditions influence factors such as salinity and temperature distributions, dispersive flows, chemical constituents, available particulate organic carbon (POC), then influence the spatial distribution, population abundance, local growth rates and biomass of invasive bivalve populations at locations over time, and at various times over spatial gradients. This proposed study will use historic samples and available long-term monitoring data to assess how environmental variability and management actions have influenced the biomass of invasive bivalve populations in the San Francisco Bay - Delta system historically. How the effects of invasive bivalve populations (benthic grazing, trace contaminant uptake and standing food stock for predators) have modulated over time and space, and how they may be expected to respond to specific conditions in the future.



DEAN F. MESSER, Ph.D.

Senior Environmental Scientist
Chief, Bay-Delta Monitoring and Analysis Section
California Department of Water Resources
901 P Street (4th Floor)
PO Box 942836
Sacramento, CA 94236-0001
(916) 651-0168
dmesser@water.ca.gov

WORK EXPERIENCE

CALIFORNIA DEPARTMENT OF WATER RESOURCES, Sacramento, California

Senior Environmental Scientist. 2004 – Present

Chief, Bay Delta Monitoring and Analysis Section

As Chief of the Bay-Delta Monitoring and Analysis Section in the Environmental Water Quality and Estuarine Studies Branch of the Division of Environmental Services, I am responsible for ensuring that the data collection, reduction, analysis, management, and reporting mandate of a water right decision issued to the Department by the State Water Resources Control Board is fulfilled, and that special studies are conducted in response to monitoring findings and the needs of management.

LARRY WALKER ASSOCIATES, INC., Davis, California

Senior Scientist. 1997-2004

Larry Walker Associates is an environmental management firm specializing in water quality issues. Services provided include water quality assessment assistance to wastewater and stormwater agencies, regulatory policy analysis, monitoring program development, watershed management administration, performance of watershed level research and assistance with strategic planning and administration.

Example projects performed with Larry Walker Associates include:

- Management and oversight of a consultant & university based team undertaking a water-borne pathogen detection/source identification project.
- Management of several stormwater Best Management Practice (BMP) monitoring and effectiveness studies throughout California.
- Participated in environmental impact research related to wastewater treatment plant expansions and stormwater management systems for several California cities.
- Developed TMDLs, bioassessment monitoring plans and wetland restoration plans.
- Developed stormwater BMP handbooks, stormwater runoff management plans and water quality monitoring guidance manuals.

UNIVERSITY OF CALIFORNIA, DAVIS

Lecturer. Department of Hydrologic Science 1995-1997

Responsible for developing and teaching courses in hydrologic and environmental resource science and performing research on water quality.

Post-Doctoral Research Associate. Center for Ecological Health Research 1994-1996

Developed, in conjunction with local, state and federal agencies, a comprehensive database of water quality data from rivers throughout California.

Research Associate – Project Manager. Department of Land, Air and Water Resources 1988-1994

Developed and supervised field sampling, laboratory analysis, data analysis, report preparation, and managed personnel for large scale, multi-year research projects examining water quality in California.

Example Projects:

- Examined the effects of clear-cut logging practices upon stream water quality in northern coastal California, (performed in conjunction with the California Department of Forestry).
- Examined water quality parameters and biological communities of agriculture drain-water evaporation ponds as part of a larger study examining selenium toxicity in California's San Joaquin Valley (performed in conjunction with the State Water Quality Control Board).

CALIFORNIA STATE UNIVERSITY, FULLERTON

Pre-doctoral Research Associate

Assistant Project Manager – Task Coordinator. Department of Biological Sciences 1986-1988

Supervised and coordinated research activities of several investigators from various disciplines, supervised laboratory and field technicians, directed data analysis and report preparation for large-scale environmental research project.

Example Projects:

- Examined water quality and sewage effluent in the Santa Ana River in southern California (performed in conjunction with the Regional Water Quality Control Board).
- Examined the distribution, abundance and mitigation of endangered species in southern California (performed in conjunction with the Department of Fish and Game).

PURDUE UNIVERSITY

Research Assistant – Assistant Project Manager. Department of Entomology 1984-1986

Co-supervised sample collection, laboratory analysis and report preparation for a large scale, multi-year entomological research project in three Midwestern states.

OTHER RELATED WORK EXPERIENCE

ENVIRONMENTAL RESEARCH ASSOCIATES (environmental consulting firm) Davis, CA 1993-1997

Consultant (at will)

Served as a technical consultant and researcher on several environmental assessment projects in the western United States.

Example Project:

- Consulted to the Klamath Indian Tribe in analyzing historical dynamics and concentrations of nutrients in Klamath Lake, Oregon.

LEADERSHIP AND ORGANIZATIONAL DEVELOPMENT

RIPARIAN IMPROVEMENT ORGANIZATION, Davis, CA (non-profit environmental organization)

Vice President 1997-1999

UNIVERSITY OF CALIFORNIA

Public Service Research Program, Undergraduate Research Committee 1996
Public Service Research and Dissemination Program, Bioregion Committee 1995
Provost's Advisory Committee on Information Technology 1994
Graduate Group Admission Committee (Co-Chair) 1994

TAHOE-BAIKAL INSTITUTE, South Lake Tahoe, CA (non-profit educational organization)

Program Coordination Committee 1993-1996
Admissions Committee (Co-Chair) 1993-1996

GRANTS AND RESEARCH DEVELOPMENT

UNIVERSITY OF CALIFORNIA

Public Service Research Program Grant Committee 1995-1996
Presidents Undergraduate Research Fellowship Committee 1995
Graduate Group Grants and Fellowships Committee (Co-Chair) 1994

GRANTS, FELLOWSHIPS AND AWARDS

Graduate Group Travel Award 1994; Chancellor's Teaching Fellowship 1993; Jastro-Shields Graduate Scholarship 1993; Natural Reserve System Research Grant 1993; Outstanding Graduate Student Teaching Award 1992, 1993; Hewlett Foundation Grant 1992; Sigma Xi Research Award 1991; Gamma Sigma Delta Honor Society, Outstanding Graduate Student Award 1986; Dean's Honor Roll 1981-1984.

EDUCATION

Ph.D., Ecology, University of California 1995

M.S., Entomology, Purdue University 1986

B.A., Biology, California State University, Fullerton 1984

RECENT AND RELEVANT PUBLICATIONS

Metzger, M. E., D. F. Messer, C. L. Beitia, C.M Myers and V. L. Kramer. 2002. The Dark Side of Stormwater Runoff Management: Disease Vectors Associated with BMPs. Stormwater 3(2): 24-39.

Kluh, S., M. E. Metzger, D. F. Messer, J. E. Hazelrigg and M. B. Madon. 2002. Stormwater, BMPs and Vectors: The Impact of New BMP Construction on Local Public Health Agencies. Stormwater 3(2): 40-46.

Messer, D.F. 1995. The Influence of Riparian Vegetation on Stream Macroinvertebrate Community Structure in an Old-Growth Forest. PhD. Dissertation. Davis, CA: University of California; 102 pp.

Messer, D. F.; C. L. Donaldson, M. S. Parker and A. W. Knight. 1994. Effects of clear-cut logging practices on benthic communities of the North Fork Caspar Creek Watershed, Jackson State Demonstration Forest: Interim Report, Spring 1987 to Spring 1992. Land, Air, and Water Resources Paper No. 100024. Davis, CA: University of California; 28 pp.

Messer, D. F. and A. W. Knight. 1990. Methods for sampling the biological communities of agricultural drainage evaporation ponds: including literature review of sampling techniques. Land, Air and Water Resources Paper No. 10016. Davis, CA: University of California; 58 pp.

Proposal Number
Proposal Name

Detailed Budget Breakdown by Task and by Fiscal Year

Applicant Name

BUDGET FOR TASK ONE (Administrative)	TOTAL AMOUNT TASK 1 All Years	Year 1			Year 2			Year 3		
		Amount per hour	Number of Hours	Total Amount for Year 1	Amount per hour	Number of Hours	Total Amount for Year 2	Amount per hour	Number of Hours	Total Amount for Year 3
Personnel										
Dean Messer	$ 5,040.00	$ 63.00	40	$ 2,520.00	$ 63.00	40	$ 2,520.00	$ -		$ -
Jan Thompson	$ 5,182.00	$ 63.75	40	$ 2,550.00	$ 65.80	40	$ 2,632.00	$ -		$ -
Heather Peterson	$ 29,280.00	$ 44.50	320	$ 14,240.00	$ 47.00	320	$ 15,040.00	$ -		$ -
Karen Gehrts	$ 40,320.00	$ 63.00	320	$ 20,160.00	$ 63.00	320	$ 20,160.00	$ -		$ -
Marc Vayssières	$ 10,080.00	$ 63.00	80	$ 5,040.00	$ 63.00	80	$ 5,040.00	$ -		$ -
	$ -	$ -		$ -			$ -	$ -		$ -
	$ -	$ -		$ -	$ -		$ -	$ -		$ -
	$ -	$ -		$ -	$ -		$ -	$ -		$ -
	$ -	$ -		$ -	$ -		$ -	$ -		$ -
	$ -	$ -		$ -	$ -		$ -	$ -		$ -
	$ -	$ -		$ -	$ -		$ -	$ -		$ -
Personnel Subtotal	**$ 89,902.00**			**$ 44,510.00**			**$ 45,392.00**			**$ -**
[1/] Benefits as percent of salary	40%			$17,804.00			$18,156.80			$0.00
Personnel Total (salary + benefits)	**$125,862.80**			**$62,314.00**			**$63,548.80**			**$0.00**
Other Costs	**Total All Years**			**Total Year 1**			**Total Year 2**			**Total Year 3**
Publication costs and Conferences	$ 15,000.00			$ 5,000.00			$ 10,000.00			$ -
	$ -			$ -			$ -			$ -
	$ -			$ -			$ -			$ -
	$ -			$ -			$ -			$ -
	$ -			$ -			$ -			$ -
	$ -			$ -			$ -			$ -
	$ -			$ -			$ -			$ -
	$ -			$ -			$ -			$ -
Other Costs Subtotal	**$ 15,000.00**			**$ 5,000.00**			**$ 10,000.00**			**$ -**
[5/] Overhead Percentage (Applied to Personnel & Other Costs)				$ -			$ -			$ -
Total Costs for Task One	**$ 140,862.80**			**$ 67,314.00**			**$ 73,548.80**			**$ -**

1/ Indicate your rate, and change formula in column immediately to the right of this cell

2/ Travel expenses and per diem must be at rates specified by the Department of Personnel Administration. The contractor is required to maintain travel receipts and records for auditing purposes. No travel out of the state of California shall be reimbursed unless prior written authorization is obtained from the State.

3/ Please provide a list and cost of major equipment ($5,000 or more) to be purchased, and complete "Equipment Detail" Worksheet

4/ Please list each subcontractor and amounts (if subcontractor not selected yet, use function like "ditch construction subcontractor")

5/ Indicate rate in column immediately to the right of this cell; and provide a description of what expenses are covered by overhead. If overhead is > 15% must provide justification

Proposal Number
Proposal Name

Detailed Budget Breakdown by Task and by Fiscal Year

Applicant Name

BUDGET FOR TASK TWO	TOTAL AMOUNT TASK 2 All Years	Year 1 Amount per hour	Year 1 Number of Hours	Year 1 Total Amount for Year 1	Year 2 Amount per hour	Year 2 Number of Hours	Year 2 Total Amount for Year 2	Year 3 Amount per hour	Year 3 Number of Hours	Year 3 Total Amount for Year 3
Personnel										
Karen Gehrts	$ -	$ -	800	$ -	$ -	300	$ -	$ -		$ -
Scientific Aide	$ 30,000.00	$ 25.00	850	$ 21,250.00	$ 25.00	350	$ 8,750.00	$ -		$ -
	$ -			$ -			$ -	$ -		$ -
	$ -			$ -			$ -	$ -		$ -
	$ -	$ -		$ -	$ -		$ -	$ -		$ -
	$ -	$ -		$ -	$ -		$ -	$ -		$ -
	$ -	$ -		$ -	$ -		$ -	$ -		$ -
	$ -	$ -		$ -	$ -		$ -	$ -		$ -
	$ -	$ -		$ -	$ -		$ -	$ -		$ -
	$ -	$ -		$ -	$ -		$ -	$ -		$ -
	$ -	$ -		$ -	$ -		$ -	$ -		$ -
Personnel Subtotal	**$ 30,000.00**			**$ 21,250.00**			**$ 8,750.00**			**$ -**
[1/] Benefits as percent of salary	40%			$8,500.00			$3,500.00			$0.00
Personnel Total (salary + benefits)	**$42,000.00**			**$29,750.00**			**$12,250.00**			**$0.00**
Other Costs	**Total All Years**			**Total Year 1**			**Total Year 2**			**Total Year 3**
Operating Expenses: (ex: seed, plant materials, irrigation supplies, software, office supplies, etc)	$ -			$ -			$ -			$ -
2/ Travel and Per Diem	$ -			$ -			$ -			$ -
3/ Equipment	$ -			$ -			$ -			$ -
4/ Sub-Contractor	$ -			$ -			$ -			$ -
4/ Sub-Contractor	$ -			$ -			$ -			$ -
4/ Sub-Contractor	$ -			$ -			$ -			$ -
4/ Sub-Contractor	$ -			$ -			$ -			$ -
4/ Sub-Contractor	$ -			$ -			$ -			$ -
Other Costs Subtotal	**$ -**			**$ -**			**$ -**			**$ -**
[5/] Overhead Percentage (Applied to Personnel & Other Costs)				$ -			$ -			$ -
Total Costs for Task Two	**$ 42,000.00**			**$ 29,750.00**			**$ 12,250.00**			**$ -**

1/ Indicate your rate, and change formula in column immediately to the right of this cell

2/ Travel expenses and per diem must be at rates specified by the Department of Personnel Administration. The contractor is required to maintain travel receipts and records for auditing purposes. No travel out of the state of California shall be reimbursed unless prior written authorization is obtained from the State.

3/ Please provide a list and cost of major equipment ($5,000 or more) to be purchased, and complete "Equipment Detail" Worksheet

4/ Please list each subcontractor and amounts (if subcontractor not selected yet, use function like "ditch construction subcontractor")

5/ Indicate rate in column immediately to the right of this cell; and provide a description of what expenses are covered by overhead. If overhead is > 15% must provide justification

BUDGET FOR TASK THREE	TOTAL AMOUNT TASK 3 All Years	Year 1 Amount per hour	Year 1 Number of Hours	Year 1 Total Amount for Year 1	Year 2 Amount per hour	Year 2 Number of Hours	Year 2 Total Amount for Year 2	Year 3 Amount per hour	Year 3 Number of Hours	Year 3 Total Amount for Year 3
Personnel										
Karen Gehrts	$ 9,450.00	$ 63.00	75	$ 4,725.00	$ 63.00	75	$ 4,725.00	$ -		$ -
Marc Vayssières	$ 9,450.00	$ 63.00	75	$ 4,725.00	$ 63.00	75	$ 4,725.00	$ -		$ -
Scientific Aide	$ 7,500.00	$ 25.00	150	$ 3,750.00	$ 25.00	150	$ 3,750.00	$ -		$ -
	$ -			$ -			$ -	$ -		$ -
	$ -	$ -		$ -	$ -		$ -	$ -		$ -

Proposal Number
Proposal Name

Detailed Budget Breakdown by Task and by Fiscal Year

Applicant Name

	$ -			$ -			$ -			$ -			$ -
	$ -			$ -			$ -			$ -			$ -
	$ -			$ -			$ -			$ -			$ -
	$ -			$ -			$ -			$ -			$ -
	$ -			$ -			$ -			$ -			$ -
	$ -			$ -			$ -			$ -			$ -
Personnel Subtotal	**$ 26,400.00**			**$ 13,200.00**			**$ 13,200.00**						**$ -**
[1/] Benefits as percent of salary	40%			$5,280.00			$5,280.00						$0.00
Personnel Total (salary + benefits)	**$36,960.00**			**$18,480.00**			**$18,480.00**						**$0.00**
Other Costs	**Total All Years**			**Total Year 1**			**Total Year 2**						**Total Year 3**
	$ -												$ -
	$ -			$ -			$ -			$ -			$ -
	$ -			$ -			$ -			$ -			$ -
	$ -			$ -			$ -			$ -			$ -
	$ -			$ -			$ -			$ -			$ -
	$ -			$ -			$ -			$ -			$ -
	$ -			$ -			$ -			$ -			$ -
Other Costs Subtotal	**$ -**			**$ -**			**$ -**						**$ -**
[5/]Overhead Percentage (Applied to Personnel & Other Costs)				$ -			$ -						$ -
Total Costs for Task Three	**$ 36,960.00**			**$ 18,480.00**			**$ 18,480.00**						**$ -**

1/ Indicate your rate, and change formula in column immediately to the right of this cell

2/ Travel expenses and per diem must be at rates specified by the Department of Personnel Administration. The contractor is required to maintain travel receipts and records for auditing purposes. No travel out of the state of California shall be reimbursed unless prior written authorization is obtained from the State.

3/ Please provide a list and cost of major equipment ($5,000 or more) to be purchased, and complete "Equipment Detail" Worksheet

4/ Please list each subcontractor and amounts (if subcontractor not selected yet, use function like "ditch construction subcontractor")

5/ Indicate rate in column immediately to the right of this cell; and provide a description of what expenses are covered by overhead. If overhead is > 15% must provide justification

		Year 1			Year 2			Year 3		
BUDGET FOR TASK FOUR	**TOTAL AMOUNT TASK 4 All Years**	**Amount per hour**	**Number of Hours**	**Total Amount for Year 1**	**Amount per hour**	**Number of Hours**	**Total Amount for Year 2**	**Amount per hour**	**Number of Hours**	**Total Amount for Year 3**
Personnel										
	$ -			$ -			$ -	$ -		$ -
	$ -			$ -			$ -	$ -		$ -
	$ -			$ -			$ -	$ -		$ -
	$ -			$ -			$ -	$ -		$ -
	$ -	$ -		$ -	$ -		$ -	$ -		$ -
	$ -	$ -		$ -	$ -		$ -	$ -		$ -
	$ -	$ -		$ -	$ -		$ -	$ -		$ -
	$ -	$ -		$ -	$ -		$ -	$ -		$ -
	$ -	$ -		$ -	$ -		$ -	$ -		$ -
	$ -	$ -		$ -	$ -		$ -	$ -		$ -
	$ -	$ -		$ -	$ -		$ -	$ -		$ -
Personnel Subtotal	**$ -**			**$ -**			**$ -**			**$ -**
[1/] Benefits as percent of salary				$0.00			$0.00			$0.00

Personnel Total (salary + benefits)	**$0.00**			**$0.00**			**$0.00**			**$0.00**
Other Costs	**Total All Years**			**Total Year 1**			**Total Year 2**			**Total Year 3**
Publications and Conferences	$ -									$ -
	$ -			$ -			$ -			$ -
	$ -			$ -			$ -			$ -
	$ -			$ -			$ -			$ -
	$ -			$ -			$ -			$ -
	$ -			$ -			$ -			$ -
	$ -			$ -			$ -			$ -
	$ -			$ -			$ -			$ -
Other Costs Subtotal	**$ -**			**$ -**			**$ -**			**$ -**
5/ Overhead Percentage (Applied to Personnel & Other Costs)				$ -			$ -			$ -
Total Costs for Task Four	**$ -**			**$ -**			**$ -**			**$ -**

1/ Indicate your rate, and change formula in column immediately to the right of this cell

2/ Travel expenses and per diem must be at rates specified by the Department of Personnel Administration. The contractor is required to maintain travel receipts and records for auditing purposes. No travel out of the state of California shall be reimbursed unless prior written authorization is obtained from the State.

3/ Please provide a list and cost of major equipment ($5,000 or more) to be purchased, and complete "Equipment Detail" Worksheet

4/ Please list each subcontractor and amounts (if subcontractor not selected yet, use function like "ditch construction subcontractor")

5/ Indicate rate in column immediately to the right of this cell; and provide a description of what expenses are covered by overhead. If overhead is > 15% must provide justification

		Year 1			Year 2			Year 3		
BUDGET FOR TASK FIVE	**TOTAL AMOUNT TASK 5 All Years**	**Amount per hour**	**Number of Hours**	**Total Amount for Year 1**	**Amount per hour**	**Number of Hours**	**Total Amount for Year 2**	**Amount per hour**	**Number of Hours**	**Total Amount for Year 3**
Personnel										
	$ -	$ -		$ -	$ -		$ -	$ -		$ -
	$ -	$ -		$ -	$ -		$ -	$ -		$ -
	$ -	$ -		$ -	$ -		$ -	$ -		$ -
	$ -	$ -		$ -	$ -		$ -	$ -		$ -
	$ -	$ -		$ -	$ -		$ -	$ -		$ -
	$ -	$ -		$ -	$ -		$ -	$ -		$ -
	$ -	$ -		$ -	$ -		$ -	$ -		$ -
	$ -	$ -		$ -	$ -		$ -	$ -		$ -
	$ -	$ -		$ -	$ -		$ -	$ -		$ -
	$ -	$ -		$ -	$ -		$ -	$ -		$ -
Personnel Subtotal	**$ -**			**$ -**			**$ -**			**$ -**
1/ Benefits as percent of salary				$0.00			$0.00			$0.00
Personnel Total (salary + benefits)	**$0.00**			**$0.00**			**$0.00**			**$0.00**
Other Costs	**Total All Years**			**Total Year 1**			**Total Year 2**			**Total Year 3**
Operating Expenses: (ex: seed, plant materials, irrigation supplies, software, office supplies, etc)	$ -			$ -			$ -			$ -
2/ Travel and Per Diem	$ -			$ -			$ -			$ -
3/ Equipment	$ -			$ -			$ -			$ -

4/ Sub-Contractor	$ -			$ -			$ -			$ -
4/ Sub-Contractor	$ -			$ -			$ -			$ -
4/ Sub-Contractor	$ -			$ -			$ -			$ -
4/ Sub-Contractor	$ -			$ -			$ -			$ -
4/ Sub-Contractor	$ -			$ -			$ -			$ -
Other Costs Subtotal	**$ -**			**$ -**			**$ -**			**$ -**
5/ Overhead Percentage (Applied to Personnel & Other Costs)				$ -			$ -			$ -
Total Costs for Task Five	**$ -**			**$ -**			**$ -**			**$ -**

1/ Indicate your rate, and change formula in column immediately to the right of this cell

2/ Travel expenses and per diem must be at rates specified by the Department of Personnel Administration. The contractor is required to maintain travel receipts and records for auditing purposes.
No travel out of the state of California shall be reimbursed unless prior written authorization is obtained from the State.

3/ Please provide a list and cost of major equipment ($5,000 or more) to be purchased, and complete "Equipment Detail" Worksheet

4/ Please list each subcontractor and amounts (if subcontractor not selected yet, use function like "ditch construction subcontractor")

5/ Indicate rate in column immediately to the right of this cell; and provide a description of what expenses are covered by overhead. If overhead is > 15% must provide justification

		Year 1			**Year 2**			**Year 3**		
BUDGET FOR TASK SIX	**TOTAL AMOUNT TASK 6 All Years**	**Amount per hour**	**Number of Hours**	**Total Amount for Year 1**	**Amount per hour**	**Number of Hours**	**Total Amount for Year 2**	**Amount per hour**	**Number of Hours**	**Total Amount for Year 3**
Personnel										
	$ -	$ -		$ -	$ -		$ -	$ -		$ -
	$ -	$ -		$ -	$ -		$ -	$ -		$ -
	$ -	$ -		$ -	$ -		$ -	$ -		$ -
	$ -	$ -		$ -	$ -		$ -	$ -		$ -
	$ -	$ -		$ -	$ -		$ -	$ -		$ -
	$ -	$ -		$ -	$ -		$ -	$ -		$ -
	$ -	$ -		$ -	$ -		$ -	$ -		$ -
	$ -	$ -		$ -	$ -		$ -	$ -		$ -
	$ -	$ -		$ -	$ -		$ -	$ -		$ -
	$ -	$ -		$ -	$ -		$ -	$ -		$ -
	$ -	$ -		$ -	$ -		$ -	$ -		$ -
Personnel Subtotal	**$ -**			**$ -**			**$ -**			**$ -**
1/ Benefits as percent of salary				$0.00			$0.00			$0.00
Personnel Total (salary + benefits)	**$0.00**			**$0.00**			**$0.00**			**$0.00**
Other Costs	**Total All Years**			**Total Year 1**			**Total Year 2**			**Total Year 3**
Operating Expenses: (ex: seed, plant materials, irrigation supplies, software, office supplies, etc)	$ -			$ -			$ -			$ -
2/ Travel and Per Diem	$ -			$ -			$ -			$ -
3/ Equipment	$ -			$ -			$ -			$ -
4/ Sub-Contractor	$ -			$ -			$ -			$ -
4/ Sub-Contractor	$ -			$ -			$ -			$ -
4/ Sub-Contractor	$ -			$ -			$ -			$ -
4/ Sub-Contractor	$ -			$ -			$ -			$ -
4/ Sub-Contractor	$ -			$ -			$ -			$ -
Other Costs Subtotal	**$ -**			**$ -**			**$ -**			**$ -**
5/ Overhead Percentage (Applied to Personnel & Other Costs)				$ -			$ -			$ -

Total Costs for Task Six	**$ -**			**$ -**			**$ -**			**$ -**

1/ Indicate your rate, and change formula in column immediately to the right of this cell

2/ Travel expenses and per diem must be at rates specified by the Department of Personnel Administration. The contractor is required to maintain travel receipts and records for auditing purposes.
No travel out of the state of California shall be reimbursed unless prior written authorization is obtained from the State.

3/ Please provide a list and cost of major equipment ($5,000 or more) to be purchased, and complete "Equipment Detail" Worksheet

4/ Please list each subcontractor and amounts (if subcontractor not selected yet, use function like "ditch construction subcontractor")

5/ Indicate rate in column immediately to the right of this cell; and provide a description of what expenses are covered by overhead. If overhead is > 15% must provide justification

		Year 1			Year 2			Year 3		
BUDGET FOR TASK SEVEN	**TOTAL AMOUNT TASK 7 All Years**	**Amount per hour**	**Number of Hours**	**Total Amount for Year 1**	**Amount per hour**	**Number of Hours**	**Total Amount for Year 2**	**Amount per hour**	**Number of Hours**	**Total Amount for Year 3**
Personnel										
	$ -	$ -		$ -	$ -		$ -	$ -		$ -
	$ -	$ -		$ -	$ -		$ -	$ -		$ -
	$ -	$ -		$ -	$ -		$ -	$ -		$ -
	$ -	$ -		$ -	$ -		$ -	$ -		$ -
	$ -	$ -		$ -	$ -		$ -	$ -		$ -
	$ -	$ -		$ -	$ -		$ -	$ -		$ -
	$ -	$ -		$ -	$ -		$ -	$ -		$ -
	$ -	$ -		$ -	$ -		$ -	$ -		$ -
	$ -	$ -		$ -	$ -		$ -	$ -		$ -
	$ -	$ -		$ -	$ -		$ -	$ -		$ -
	$ -	$ -		$ -	$ -		$ -	$ -		$ -
Personnel Subtotal	**$ -**			**$ -**			**$ -**			**$ -**
1/ Benefits as percent of salary				$0.00			$0.00			$0.00
Personnel Total (salary + benefits)	**$0.00**			**$0.00**			**$0.00**			**$0.00**
Other Costs	**Total All Years**			**Total Year 1**			**Total Year 2**			**Total Year 3**
Operating Expenses: (ex: seed, plant materials, irrigation supplies, software, office supplies, etc)	$ -			$ -			$ -			$ -
2/ Travel and Per Diem	$ -			$ -			$ -			$ -
3/ Equipment	$ -			$ -			$ -			$ -
4/ Sub-Contractor	$ -			$ -			$ -			$ -
4/ Sub-Contractor	$ -			$ -			$ -			$ -
4/ Sub-Contractor	$ -			$ -			$ -			$ -
4/ Sub-Contractor	$ -			$ -			$ -			$ -
4/ Sub-Contractor	$ -			$ -			$ -			$ -
Other Costs Subtotal	**$ -**			**$ -**			**$ -**			**$ -**
5/ Overhead Percentage (Applied to Personnel & Other Costs)				$ -			$ -			$ -
Total Costs for Task Seven	**$ -**			**$ -**			**$ -**			**$ -**

1/ Indicate your rate, and change formula in column immediately to the right of this cell

2/ Travel expenses and per diem must be at rates specified by the Department of Personnel Administration. The contractor is required to maintain travel receipts and records for auditing purposes.
No travel out of the state of California shall be reimbursed unless prior written authorization is obtained from the State.

3/ Please provide a list and cost of major equipment ($5,000 or more) to be purchased, and complete "Equipment Detail" Worksheet

4/ Please list each subcontractor and amounts (if subcontractor not selected yet, use function like "ditch construction subcontractor")

5/ Indicate rate in column immediately to the right of this cell; and provide a description of what expenses are covered by overhead. If overhead is > 15% must provide justification

Proposal Number
Proposal Name

Detailed Budget Breakdown by Task and by Fiscal Year

Applicant Name

		Year 1			Year 2			Year 3		
BUDGET FOR TASK EIGHT	**TOTAL AMOUNT TASK 8 All Years**	**Amount per hour**	**Number of Hours**	**Total Amount for Year 1**	**Amount per hour**	**Number of Hours**	**Total Amount for Year 2**	**Amount per hour**	**Number of Hours**	**Total Amount for Year 3**
Personnel										
	$ -	$ -		$ -	$ -		$ -	$ -		$ -
	$ -	$ -		$ -	$ -		$ -	$ -		$ -
	$ -	$ -		$ -	$ -		$ -	$ -		$ -
	$ -	$ -		$ -	$ -		$ -	$ -		$ -
	$ -	$ -		$ -	$ -		$ -	$ -		$ -
	$ -	$ -		$ -	$ -		$ -	$ -		$ -
	$ -	$ -		$ -	$ -		$ -	$ -		$ -
	$ -	$ -		$ -	$ -		$ -	$ -		$ -
	$ -	$ -		$ -	$ -		$ -	$ -		$ -
	$ -	$ -		$ -	$ -		$ -	$ -		$ -
	$ -	$ -		$ -	$ -		$ -	$ -		$ -
Personnel Subtotal	**$ -**			**$ -**			**$ -**			**$ -**
[1/] Benefits as percent of salary				$0.00			$0.00			$0.00
Personnel Total (salary + benefits)	**$0.00**			**$0.00**			**$0.00**			**$0.00**
Other Costs	**Total All Years**			**Total Year 1**			**Total Year 2**			**Total Year 3**
Operating Expenses: (ex: seed, plant materials, irrigation supplies, software, office supplies, etc)	$ -			$ -			$ -			$ -
2/ Travel and Per Diem	$ -			$ -			$ -			$ -
3/ Equipment	$ -			$ -			$ -			$ -
4/ Sub-Contractor	$ -			$ -			$ -			$ -
4/ Sub-Contractor	$ -			$ -			$ -			$ -
4/ Sub-Contractor	$ -			$ -			$ -			$ -
4/ Sub-Contractor	$ -			$ -			$ -			$ -
4/ Sub-Contractor	$ -			$ -			$ -			$ -
Other Costs Subtotal	**$ -**			**$ -**			**$ -**			**$ -**
[5/]Overhead Percentage (Applied to Personnel & Other Costs)				$ -			$ -			$ -
Total Costs for Task Eight	**$ -**			**$ -**			**$ -**			**$ -**

1/ Indicate your rate, and change formula in column immediately to the right of this cell

2/ Travel expenses and per diem must be at rates specified by the Department of Personnel Administration. The contractor is required to maintain travel receipts and records for auditing purposes.
No travel out of the state of California shall be reimbursed unless prior written authorization is obtained from the State.

3/ Please provide a list and cost of major equipment ($5,000 or more) to be purchased, and complete "Equipment Detail" Worksheet

4/ Please list each subcontractor and amounts (if subcontractor not selected yet, use function like "ditch construction subcontractor")

5/ Indicate rate in column immediately to the right of this cell; and provide a description of what expenses are covered by overhead. If overhead is > 15% must provide justification

		Year 1			Year 2			Year 3		
BUDGET FOR TASK NINE	**TOTAL AMOUNT TASK 9 All Years**	**Amount per hour**	**Number of Hours**	**Total Amount for Year 1**	**Amount per hour**	**Number of Hours**	**Total Amount for Year 2**	**Amount per hour**	**Number of Hours**	**Total Amount for Year 3**
Personnel										
	$ -	$ -		$ -	$ -		$ -	$ -		$ -
	$ -	$ -		$ -	$ -		$ -	$ -		$ -
	$ -	$ -		$ -	$ -		$ -	$ -		$ -
	$ -	$ -		$ -	$ -		$ -	$ -		$ -
	$ -	$ -		$ -	$ -		$ -	$ -		$ -

Proposal Number
Proposal Name

Detailed Budget Breakdown by Task and by Fiscal Year

Applicant Name

	$ -	$ -		$ -	$ -		$ -	$ -		$ -
	$ -	$ -		$ -	$ -		$ -	$ -		$ -
	$ -	$ -		$ -	$ -		$ -	$ -		$ -
	$ -	$ -		$ -	$ -		$ -	$ -		$ -
	$ -	$ -		$ -	$ -		$ -	$ -		$ -
	$ -	$ -		$ -	$ -		$ -	$ -		$ -
Personnel Subtotal	**$ -**			**$ -**			**$ -**			**$ -**
1/ Benefits as percent of salary				$0.00			$0.00			$0.00
Personnel Total (salary + benefits)	**$0.00**			**$0.00**			**$0.00**			**$0.00**
Other Costs	**Total All Years**			**Total Year 1**			**Total Year 2**			**Total Year 3**
Operating Expenses: (ex: seed, plant materials, irrigation supplies, software, office supplies, etc)	$ -			$ -			$ -			$ -
2/ Travel and Per Diem	$ -			$ -			$ -			$ -
3/ Equipment	$ -			$ -			$ -			$ -
4/ Sub-Contractor	$ -			$ -			$ -			$ -
4/ Sub-Contractor	$ -			$ -			$ -			$ -
4/ Sub-Contractor	$ -			$ -			$ -			$ -
4/ Sub-Contractor	$ -			$ -			$ -			$ -
4/ Sub-Contractor	$ -			$ -			$ -			$ -
Other Costs Subtotal	**$ -**			**$ -**			**$ -**			**$ -**
5/ Overhead Percentage (Applied to Personnel & Other Costs)				$ -			$ -			$ -
Total Costs for Task Nine	**$ -**			**$ -**			**$ -**			**$ -**

1/ Indicate your rate, and change formula in column immediately to the right of this cell

2/ Travel expenses and per diem must be at rates specified by the Department of Personnel Administration. The contractor is required to maintain travel receipts and records for auditing purposes.
No travel out of the state of California shall be reimbursed unless prior written authorization is obtained from the State.

3/ Please provide a list and cost of major equipment ($5,000 or more) to be purchased, and complete "Equipment Detail" Worksheet

4/ Please list each subcontractor and amounts (if subcontractor not selected yet, use function like "ditch construction subcontractor")

5/ Indicate rate in column immediately to the right of this cell; and provide a description of what expenses are covered by overhead. If overhead is > 15% must provide justification

		Year 1			**Year 2**			**Year 3**		
BUDGET FOR TASK TEN	**TOTAL AMOUNT TASK 10 All Years**	**Amount per hour**	**Number of Hours**	**Total Amount for Year 1**	**Amount per hour**	**Number of Hours**	**Total Amount for Year 2**	**Amount per hour**	**Number of Hours**	**Total Amount for Year 3**
Personnel										
	$ -	$ -		$ -	$ -		$ -	$ -		$ -
	$ -	$ -		$ -	$ -		$ -	$ -		$ -
	$ -	$ -		$ -	$ -		$ -	$ -		$ -
	$ -	$ -		$ -	$ -		$ -	$ -		$ -
	$ -	$ -		$ -	$ -		$ -	$ -		$ -
	$ -	$ -		$ -	$ -		$ -	$ -		$ -
	$ -	$ -		$ -	$ -		$ -	$ -		$ -
	$ -	$ -		$ -	$ -		$ -	$ -		$ -
	$ -	$ -		$ -	$ -		$ -	$ -		$ -
	$ -	$ -		$ -	$ -		$ -	$ -		$ -
	$ -	$ -		$ -	$ -		$ -	$ -		$ -
Personnel Subtotal	**$ -**			**$ -**			**$ -**			**$ -**
1/ Benefits as percent of salary				$0.00			$0.00			$0.00

Personnel Total (salary + benefits)	**$0.00**			**$0.00**			**$0.00**			**$0.00**
Other Costs	**Total All Years**			**Total Year 1**			**Total Year 2**			**Total Year 3**
Operating Expenses: (ex: seed, plant materials, irrigation supplies, software, office supplies, etc)	$ -			$ -			$ -			$ -
2/ Travel and Per Diem	$ -			$ -			$ -			$ -
3/ Equipment	$ -			$ -			$ -			$ -
4/ Sub-Contractor	$ -			$ -			$ -			$ -
4/ Sub-Contractor	$ -			$ -			$ -			$ -
4/ Sub-Contractor	$ -			$ -			$ -			$ -
4/ Sub-Contractor	$ -			$ -			$ -			$ -
4/ Sub-Contractor	$ -			$ -			$ -			$ -
Other Costs Subtotal	**$ -**			**$ -**			**$ -**			**$ -**
5/ Overhead Percentage (Applied to Personnel & Other Costs)				$ -			$ -			$ -
Total Costs for Task Ten	**$ -**			**$ -**			**$ -**			**$ -**

1/ Indicate your rate, and change formula in column immediately to the right of this cell

2/ Travel expenses and per diem must be at rates specified by the Department of Personnel Administration. The contractor is required to maintain travel receipts and records for auditing purposes.
No travel out of the state of California shall be reimbursed unless prior written authorization is obtained from the State.

3/ Please provide a list and cost of major equipment ($5,000 or more) to be purchased, and complete "Equipment Detail" Worksheet

4/ Please list each subcontractor and amounts (if subcontractor not selected yet, use function like "ditch construction subcontractor")

5/ Indicate rate in column immediately to the right of this cell; and provide a description of what expenses are covered by overhead. If overhead is > 15% must provide justification

		Year 1			Year 2			Year 3		
BUDGET FOR TASK ELEVEN	**TOTAL AMOUNT TASK 11 All Years**	**Amount per hour**	**Number of Hours**	**Total Amount for Year 1**	**Amount per hour**	**Number of Hours**	**Total Amount for Year 2**	**Amount per hour**	**Number of Hours**	**Total Amount for Year 3**
Personnel										
	$ -	$ -		$ -	$ -		$ -	$ -		$ -
	$ -	$ -		$ -	$ -		$ -	$ -		$ -
	$ -	$ -		$ -	$ -		$ -	$ -		$ -
	$ -	$ -		$ -	$ -		$ -	$ -		$ -
	$ -	$ -		$ -	$ -		$ -	$ -		$ -
	$ -	$ -		$ -	$ -		$ -	$ -		$ -
	$ -	$ -		$ -	$ -		$ -	$ -		$ -
	$ -	$ -		$ -	$ -		$ -	$ -		$ -
	$ -	$ -		$ -	$ -		$ -	$ -		$ -
	$ -	$ -		$ -	$ -		$ -	$ -		$ -
	$ -	$ -		$ -	$ -		$ -	$ -		$ -
Personnel Subtotal	**$ -**			**$ -**			**$ -**			**$ -**
1/ Benefits as percent of salary				$0.00			$0.00			$0.00
Personnel Total (salary + benefits)	**$0.00**			**$0.00**			**$0.00**			**$0.00**
Other Costs	**Total All Years**			**Total Year 1**			**Total Year 2**			**Total Year 3**
Operating Expenses: (ex: seed, plant materials, irrigation supplies, software, office supplies, etc)	$ -			$ -			$ -			$ -
2/ Travel and Per Diem	$ -			$ -			$ -			$ -
3/ Equipment	$ -			$ -			$ -			$ -

4/ Sub-Contractor	$ -			$ -			$ -			$ -
4/ Sub-Contractor	$ -			$ -			$ -			$ -
4/ Sub-Contractor	$ -			$ -			$ -			$ -
4/ Sub-Contractor	$ -			$ -			$ -			$ -
4/ Sub-Contractor	$ -			$ -			$ -			$ -
Other Costs Subtotal	**$ -**			**$ -**			**$ -**			**$ -**
5/ Overhead Percentage (Applied to Personnel & Other Costs)				$ -			$ -			$ -
Total Costs for Task Eleven	**$ -**			**$ -**			**$ -**			**$ -**

1/ Indicate your rate, and change formula in column immediately to the right of this cell

2/ Travel expenses and per diem must be at rates specified by the Department of Personnel Administration. The contractor is required to maintain travel receipts and records for auditing purposes. No travel out of the state of California shall be reimbursed unless prior written authorization is obtained from the State.

3/ Please provide a list and cost of major equipment ($5,000 or more) to be purchased, and complete "Equipment Detail" Worksheet

4/ Please list each subcontractor and amounts (if subcontractor not selected yet, use function like "ditch construction subcontractor")

5/ Indicate rate in column immediately to the right of this cell; and provide a description of what expenses are covered by overhead. If overhead is > 15% must provide justification

BUDGET FOR TASK TWELVE	**TOTAL AMOUNT TASK 12 All Years**	**Year 1** Amount per hour	**Year 1** Number of Hours	**Year 1** Total Amount for Year 1	**Year 2** Amount per hour	**Year 2** Number of Hours	**Year 2** Total Amount for Year 2	**Year 3** Amount per hour	**Year 3** Number of Hours	**Year 3** Total Amount for Year 3
Personnel										
	$ -	$ -		$ -	$ -		$ -	$ -		$ -
	$ -	$ -		$ -	$ -		$ -	$ -		$ -
	$ -	$ -		$ -	$ -		$ -	$ -		$ -
	$ -	$ -		$ -	$ -		$ -	$ -		$ -
	$ -	$ -		$ -	$ -		$ -	$ -		$ -
	$ -	$ -		$ -	$ -		$ -	$ -		$ -
	$ -	$ -		$ -	$ -		$ -	$ -		$ -
	$ -	$ -		$ -	$ -		$ -	$ -		$ -
	$ -	$ -		$ -	$ -		$ -	$ -		$ -
	$ -	$ -		$ -	$ -		$ -	$ -		$ -
	$ -	$ -		$ -	$ -		$ -	$ -		$ -
Personnel Subtotal	**$ -**			**$ -**			**$ -**			**$ -**
1/ Benefits as percent of salary				$0.00			$0.00			$0.00
Personnel Total (salary + benefits)	**$0.00**			**$0.00**			**$0.00**			**$0.00**
Other Costs	**Total All Years**			**Total Year 1**			**Total Year 2**			**Total Year 3**
Operating Expenses: (ex: seed, plant materials, irrigation supplies, software, office supplies, etc)	$ -			$ -			$ -			$ -
2/ Travel and Per Diem	$ -			$ -			$ -			$ -
3/ Equipment	$ -			$ -			$ -			$ -
4/ Sub-Contractor	$ -			$ -			$ -			$ -
4/ Sub-Contractor	$ -			$ -			$ -			$ -
4/ Sub-Contractor	$ -			$ -			$ -			$ -
4/ Sub-Contractor	$ -			$ -			$ -			$ -
4/ Sub-Contractor	$ -			$ -			$ -			$ -
Other Costs Subtotal	**$ -**			**$ -**			**$ -**			**$ -**
5/ Overhead Percentage (Applied to Personnel & Other Costs)				$ -			$ -			$ -

Total Costs for Task Twelve	**$ -**			**$ -**			**$ -**			**$ -**

1/ Indicate your rate, and change formula in column immediately to the right of this cell

2/ Travel expenses and per diem must be at rates specified by the Department of Personnel Administration. The contractor is required to maintain travel receipts and records for auditing purposes.
No travel out of the state of California shall be reimbursed unless prior written authorization is obtained from the State.

3/ Please provide a list and cost of major equipment ($5,000 or more) to be purchased, and complete "Equipment Detail" Worksheet

4/ Please list each subcontractor and amounts (if subcontractor not selected yet, use function like "ditch construction subcontractor")

5/ Indicate rate in column immediately to the right of this cell; and provide a description of what expenses are covered by overhead. If overhead is > 15% must provide justification

		Year 1			Year 2			Year 3		
BUDGET FOR TASK THIRTEEN	**TOTAL AMOUNT TASK 13 All Years**	**Amount per hour**	**Number of Hours**	**Total Amount for Year 1**	**Amount per hour**	**Number of Hours**	**Total Amount for Year 2**	**Amount per hour**	**Number of Hours**	**Total Amount for Year 3**
Personnel										
	$ -	$ -		$ -	$ -		$ -	$ -		$ -
	$ -	$ -		$ -	$ -		$ -	$ -		$ -
	$ -	$ -		$ -	$ -		$ -	$ -		$ -
	$ -	$ -		$ -	$ -		$ -	$ -		$ -
	$ -	$ -		$ -	$ -		$ -	$ -		$ -
	$ -	$ -		$ -	$ -		$ -	$ -		$ -
	$ -	$ -		$ -	$ -		$ -	$ -		$ -
	$ -	$ -		$ -	$ -		$ -	$ -		$ -
	$ -	$ -		$ -	$ -		$ -	$ -		$ -
	$ -	$ -		$ -	$ -		$ -	$ -		$ -
	$ -	$ -		$ -	$ -		$ -	$ -		$ -
Personnel Subtotal	**$ -**			**$ -**			**$ -**			**$ -**
[1/] Benefits as percent of salary				$0.00			$0.00			$0.00
Personnel Total (salary + benefits)	**$0.00**			**$0.00**			**$0.00**			**$0.00**
Other Costs	**Total All Years**			**Total Year 1**			**Total Year 2**			**Total Year 3**
Operating Expenses: (ex: seed, plant materials, irrigation supplies, software, office supplies, etc)	$ -			$ -			$ -			$ -
2/ Travel and Per Diem	$ -			$ -			$ -			$ -
3/ Equipment	$ -			$ -			$ -			$ -
4/ Sub-Contractor	$ -			$ -			$ -			$ -
4/ Sub-Contractor	$ -			$ -			$ -			$ -
4/ Sub-Contractor	$ -			$ -			$ -			$ -
4/ Sub-Contractor	$ -			$ -			$ -			$ -
4/ Sub-Contractor	$ -			$ -			$ -			$ -
Other Costs Subtotal	**$ -**			**$ -**			**$ -**			**$ -**
[5/] Overhead Percentage (Applied to Personnel & Other Costs)				$ -			$ -			$ -
Total Costs for Task Thirteen	**$ -**			**$ -**			**$ -**			**$ -**

1/ Indicate your rate, and change formula in column immediately to the right of this cell

2/ Travel expenses and per diem must be at rates specified by the Department of Personnel Administration. The contractor is required to maintain travel receipts and records for auditing purposes.
No travel out of the state of California shall be reimbursed unless prior written authorization is obtained from the State.

3/ Please provide a list and cost of major equipment ($5,000 or more) to be purchased, and complete "Equipment Detail" Worksheet

4/ Please list each subcontractor and amounts (if subcontractor not selected yet, use function like "ditch construction subcontractor")

5/ Indicate rate in column immediately to the right of this cell; and provide a description of what expenses are covered by overhead. If overhead is > 15% must provide justification

Proposal Number
Proposal Name

Detailed Budget Breakdown by Task and by Fiscal Year

Applicant Name

		Year 1			Year 2			Year 3		
BUDGET FOR TASK FOURTEEN	**TOTAL AMOUNT TASK 14 All Years**	**Amount per hour**	**Number of Hours**	**Total Amount for Year 1**	**Amount per hour**	**Number of Hours**	**Total Amount for Year 2**	**Amount per hour**	**Number of Hours**	**Total Amount for Year 3**
Personnel										
	$ -	$ -		$ -	$ -		$ -	$ -		$ -
	$ -	$ -		$ -	$ -		$ -	$ -		$ -
	$ -	$ -		$ -	$ -		$ -	$ -		$ -
	$ -	$ -		$ -	$ -		$ -	$ -		$ -
	$ -	$ -		$ -	$ -		$ -	$ -		$ -
	$ -	$ -		$ -	$ -		$ -	$ -		$ -
	$ -	$ -		$ -	$ -		$ -	$ -		$ -
	$ -	$ -		$ -	$ -		$ -	$ -		$ -
	$ -	$ -		$ -	$ -		$ -	$ -		$ -
	$ -	$ -		$ -	$ -		$ -	$ -		$ -
	$ -	$ -		$ -	$ -		$ -	$ -		$ -
Personnel Subtotal	**$ -**			**$ -**			**$ -**			**$ -**
1/ Benefits as percent of salary				$0.00			$0.00			$0.00
Personnel Total (salary + benefits)	**$0.00**			**$0.00**			**$0.00**			**$0.00**
Other Costs	**Total All Years**			**Total Year 1**			**Total Year 2**			**Total Year 3**
Operating Expenses: (ex: seed, plant materials, irrigation supplies, software, office supplies, etc)	$ -			$ -			$ -			$ -
2/ Travel and Per Diem	$ -			$ -			$ -			$ -
3/ Equipment	$ -			$ -			$ -			$ -
4/ Sub-Contractor	$ -			$ -			$ -			$ -
4/ Sub-Contractor	$ -			$ -			$ -			$ -
4/ Sub-Contractor	$ -			$ -			$ -			$ -
4/ Sub-Contractor	$ -			$ -			$ -			$ -
4/ Sub-Contractor	$ -			$ -			$ -			$ -
Other Costs Subtotal	**$ -**			**$ -**			**$ -**			**$ -**
5/ Overhead Percentage (Applied to Personnel & Other Costs)				$ -			$ -			$ -
Total Costs for Task Fourteen	**$ -**			**$ -**			**$ -**			**$ -**

1/ Indicate your rate, and change formula in column immediately to the right of this cell

2/ Travel expenses and per diem must be at rates specified by the Department of Personnel Administration. The contractor is required to maintain travel receipts and records for auditing purposes.
No travel out of the state of California shall be reimbursed unless prior written authorization is obtained from the State.

3/ Please provide a list and cost of major equipment ($5,000 or more) to be purchased, and complete "Equipment Detail" Worksheet

4/ Please list each subcontractor and amounts (if subcontractor not selected yet, use function like "ditch construction subcontractor")

5/ Indicate rate in column immediately to the right of this cell; and provide a description of what expenses are covered by overhead. If overhead is > 15% must provide justification

		Year 1			Year 2			Year 3		
BUDGET FOR TASK FIFTEEN	**TOTAL AMOUNT TASK 15 All Years**	**Amount per hour**	**Number of Hours**	**Total Amount for Year 1**	**Amount per hour**	**Number of Hours**	**Total Amount for Year 2**	**Amount per hour**	**Number of Hours**	**Total Amount for Year 3**
Personnel										
	$ -	$ -		$ -	$ -		$ -	$ -		$ -
	$ -	$ -		$ -	$ -		$ -	$ -		$ -
	$ -	$ -		$ -	$ -		$ -	$ -		$ -
	$ -	$ -		$ -	$ -		$ -	$ -		$ -
	$ -	$ -		$ -	$ -		$ -	$ -		$ -

Proposal Number
Proposal Name

Detailed Budget Breakdown by Task and by Fiscal Year

Applicant Name

	$ -			$ -			$ -			$ -		
	$ -			$ -			$ -			$ -		
	$ -			$ -			$ -			$ -		
	$ -			$ -			$ -			$ -		
	$ -			$ -			$ -			$ -		
	$ -			$ -			$ -			$ -		
Personnel Subtotal	**$ -**			**$ -**			**$ -**			**$ -**		
[1/] Benefits as percent of salary				$0.00			$0.00			$0.00		
Personnel Total (salary + benefits)	**$0.00**			**$0.00**			**$0.00**			**$0.00**		
Other Costs	**Total All Years**			**Total Year 1**			**Total Year 2**			**Total Year 3**		
Operating Expenses: (ex: seed, plant materials, irrigation supplies, software, office supplies, etc)	$ -			$ -			$ -			$ -		
2/ Travel and Per Diem	$ -			$ -			$ -			$ -		
3/ Equipment	$ -			$ -			$ -			$ -		
4/ Sub-Contractor	$ -			$ -			$ -			$ -		
4/ Sub-Contractor	$ -			$ -			$ -			$ -		
4/ Sub-Contractor	$ -			$ -			$ -			$ -		
4/ Sub-Contractor	$ -			$ -			$ -			$ -		
4/ Sub-Contractor	$ -			$ -			$ -			$ -		
Other Costs Subtotal	**$ -**			**$ -**			**$ -**			**$ -**		
[5/]Overhead Percentage (Applied to Personnel & Other Costs)				$ -			$ -			$ -		
Total Costs for Task Fifteen	**$ -**			**$ -**			**$ -**			**$ -**		

1/ Indicate your rate, and change formula in column immediately to the right of this cell

2/ Travel expenses and per diem must be at rates specified by the Department of Personnel Administration. The contractor is required to maintain travel receipts and records for auditing purposes. No travel out of the state of California shall be reimbursed unless prior written authorization is obtained from the State.

3/ Please provide a list and cost of major equipment ($5,000 or more) to be purchased, and complete "Equipment Detail" Worksheet

4/ Please list each subcontractor and amounts (if subcontractor not selected yet, use function like "ditch construction subcontractor")

5/ Indicate rate in column immediately to the right of this cell; and provide a description of what expenses are covered by overhead. If overhead is > 15% must provide justification

Budget justification

The proposed project is a continuation of a pilot study that has been successfully conducted by DWR in the past. The sample material has already been collected, which is a major cost savings as no new samples need to be collected. No permits are needed. All laboratory space and equipment have been secured (at no additional cost). The methods that are proposed to be used for measuring bivalve samples, compiling size frequency distributions, and estimating biomass have been successfully used by contributing authors (Jan Thompson) in previous studies. The staff has already been trained. Even with extensive training, archived samples take an average of 4 hours to sort, identify, count and take length measurements. For this reason, salaries for personnel are the only significant expense.

Cost Sharing

Task 2 (Biomass Measurement) will be conducted by K. Gehrts, and one Scientific Aid (DWR). Dr. J. Thompson (USGS) will provide methodology and support. As mentioned in the budget justification, staff salaries are the only major expense because lab space and equipment have already been secured with DWR and USGS. Due to the time necessary to sort, identify, count and measure DWR has agreed to pay the salary of the lead environmental scientist, K. Gehrts.

Signature

California Home

banner_california

California Bay-Delta Authority | home | my information | help | admin | banner_reset_password_blank

Signature

The applicant for this proposal must submit this form by printing it, signing below, and faxing it to +1 877-408-9310. Send exactly one form per transmission.

Failure to sign and submit this form will result in the application not being considered for funding. The individual submitting this proposal will receive e-mail confirmation as soon as this signature page has been processed.

The individual signing below declares that:

- all representations in this proposal are truthful;
- the individual signing the form is authorized to submit the application on behalf of the applicant (if applicant is an entity or organization);
- the applicant has read and understood the conflict of interest and confidentiality discussion under the Confidentiality and Conflict of Interest Section in the main body of the PSP and waives any and all rights to privacy and confidentiality of the proposal on behalf of the applicant, to the extent provided in this PSP; and
- the applicant has read and understood all attachments of this PSP.

proposal title: ~~Alternate Uses of Exotic Species Outside of Delta~~ Analysis of Archived Samples to Assess Patterns of Historic Invasive Bivalve Biomass

proposal number: 2006.01-~~0001~~ 0078

applicant organization: ~~Fast and Friendly Benthologists of the Sierra~~ California Department of Water Resources

applicant contact: ~~Ms. Danielle Wilson~~ Ms Barbara McDonnell

applicant signature Barbara J McDonnell

date Aug 31, 2006

Help is available: help@solicitation.calwater.ca.gov, +1 877 408-9310

We care about the data we collect. Please read our privacy policy.

URL: https://solicitation.calwater.ca.gov/solicitations/2006.01/proposals/0001/forms/60
time: 2006-08-31 13:51:27 PST
user ID: dwilson
client IP: 65.170.144.66