Phytoplankton Communities In The San Francisco Estuary: Monitoring And Management Using A Submersible Spectrofluorometer

prepared by Mueller−Solger, Anke

submitted to Science Program 2004

compiled 2005−01−06 14:37:29 PST

Project

This proposal is for the Science Program 2004 solicitation as prepared by Mueller−Solger, Anke .

The submission deadline is 2005−01−06 17:00:00 PST (approximately 143 minutes from now).

Proposal updates will be disabled immediately after the deadline. All forms, including the signature form, must be completed, compiled and acknowledged in order to be eligible for consideration and review. Allow at least one hour for Science Program staff to verify and file signature pages after they are received.

Instructions

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Proposal Title	***Phytoplankton communities in the San Francisco Estuary: monitoring and management using a submersible spectrofluorometer***	
Institutions	California Department of Water Resources University of California at Davis	*List each institution involved, one per line.*
Proposal Document		*You have already uploaded a proposal document. View it to verify that it appears as you expect. You may replace it by uploading another document*
Project Duration	***24 months***	

Is the start date a determining factor to the successful outcome of the proposed effort?
X No.
− Yes. Anticipated start date of this effort:

Select all of the following study topics which apply to this proposal.
− life cycle models and population biology of key species
X environmental influences on key species and ecosystems
X relative stresses on key fish species
X direct and indirect effects of diversions on at−risk species
X processes controlling Delta water quality
X implications of future change on regional hydrology, water operations, and environmental processes
− water management models for prediction, optimization, and strategic assessments
X assessment and monitoring
X salmonid−related projects
X Delta smelt−related projects

Select as many keywords as necessary to describe this proposal (minimum of 3).
X adaptive management
− aquatic plants
X benthic invertebrates
X biological indicators
− birds
− neotropical migratory birds
− shorebirds
− upland birds
− wading birds
− waterfowl
X climate
− climate change
− precipitation
− sea level rise
− snowmelt
X contaminants / toxicants / pollutants
− contaminants and toxicity of unknown origin
− emerging contaminants

− mercury
− nutrients and oxygen depleting substances
− organic carbon and disinfection byproduct precursors
− persistent organic contaminants
− pesticides
− salinity
− sediment and turbidity
− selenium
− trace metals
X database management
− economics
− engineering
− civil
− environmental
− hydraulic
X environmental education
− environmental impact analysis
− environmental laws and regulations
− environmental risk assessment
− fish biology
− bass and other centarchids
− delta smelt
− longfin smelt
− other species
− salmon and steelhead
− splittail
− striped bass
− sturgeon
X fish management and facilities
− hatcheries
− ladders and passage
− screens
− forestry
− genetics
X geochemistry
X geographic information systems (GIS)
− geology
− geomorphology
− groundwater
X habitat
− benthos
X channels and sloughs
X flooded islands
X floodplains and bypasses
X oceanic
− reservoirs
− riparian
X rivers and streams
X shallow water
− upland habitat
− vernal pools
X water column
X wetlands, freshwater
X wetlands, seasonal
X wetlands, tidal
X human health
X hydrodynamics
X hydrology
− insects
X invasive species / non−native species / exotic species
− land use management, planning, and zoning
X limnology
− mammals
− large
− small

− ***microbiology / bacteriology***
X modeling
− conceptual
− quantitative
X monitoring
X natural resource management
X performance measures
X phytoplankton
− ***plants***
X primary productivity
− ***reptiles***
X restoration ecology
− ***riparian ecology***
− ***sediment***
− ***soil science***
X statistics
− ***subsidence***
X trophic dynamics and food webs
X water operations
− barriers
X diversions / pumps / intakes / exports
− gates
− levees
− reservoirs
X water quality management
− ag runoff
− mine waste assessment and remediation
− remediation
− temperature
− urban runoff
X water quality assessment and monitoring
X water resource management
− ***water supply***
− demand
− environmental water account
− water level
− water storage
− ***watershed management***
− ***weed science***
X wildlife
X ecology
X management
− wildlife−friendly agriculture
X zooplankton
X administrative

Indicate whether your project area is local, regional, or system−wide. If it is local, provide a central ZIP Code. If it is regional, provide the central ZIP Code and choose the counties affected. If it is system−wide, describe the area using information such as water bodies, river miles, and road intersections.	
− local	ZIP Code:
X regional	ZIP Code: ***95816*** counties: ***Contra Costa*** ***Marin*** ***Napa*** ***Sacramento*** ***San Joaquin***

	Solano ***Sonoma*** ***Yolo***
− system−wide	

Does your project fall on or adjacent to tribal lands?
No.

(Refer to California Indian reservations *to locate tribal lands.)*
If it does, list the tribal lands.

Has a proposal for this effort or a similar effort ever been submitted to CALFED for funding or to any other public agency for funding?
No.

If yes, complete the table below.

Status	Proposal Title	Funding Source	Amount	Comments

Has the lead scientist or principal investigator of this effort ever submitted a proposal to CALFED for funding or to any other public agency for funding?
Yes.

If yes, provide the name of the project, when it was submitted, and to which agency and funding mechanism if was submitted. Also describe the outcome and any other pertinent details describing the proposal's current status.

Ongoing CALFED ERP Project ERP−01−N50 / CALFED 2001−K221 "Food resources for zooplankton in the Sacramento−San Joaquin River Delta" administered through NFWF. Lead scientist (Anke Mueller−Solger) was principal proposal writer and is co−PI and project manager. This project will end in March 2005 (no cost extension requested and granted in 2004 due to initial funding delays). Results have been reported in quarterly reports and through many presentations, including a recent oral presentation by Hall et al at the 2004 Calfed Science Conference, and three manuscripts for submission to peer−reviewed journals as well as an IEP newsletter article are nearing completion at this time. Lead scientist has also participated in three other completed and ongoing Calfed funded projects.

All applicants must identify all sources of funding other than the funds requested through this solicitation to support the effort outlined in their proposal. Applicants must include the status of these commitments (tentative, approved, received), the source, and any cost−sharing requirements. Successful proposals that demonstrate multiple sources of funding must have the commitment of the non−Science Program PSP related funding within 30 days of notification of approval of Science Program PSP funds. If an applicant fails to secure the non−Science Program PSP funds identified in the proposal, and as a result has insufficient funds to complete the project, CBDA retains the option to amend or terminate the award. The California Bay−Delta Authority reserves the right to audit grantees.

Status	Proposal Title	Funding Source	Period Of Commitment	Requirements And Comments
approved	***Ongoing IEP Monitoring Funds for D−1641 Mandated Monitoring Progra***	***Interagency Monitoring Program***	***Ongoing***	***Funding for mandated monitoring***

Are you specifically seeking non−federal cost−share funds for this proposal?
No.

In addition to the general funds available, are you targeting additional funds set aside specifically for collaborative proposals?
Yes.

List people you feel are qualified to act as scientific reviewers for this proposal and are not associated with CALFED.

Full Name	Organization	Telephone	E−Mail	Expertise
Wayne A. Wurtsbaugh	***Utah State University***	***(435) 797−2584***	***WURTS@CC.USU.EDU***	***biological indicators***
Hunter J. Carrick	***The Pennsylvania State University***	***(814) 865−9219***	***hjc11@psu.edu***	***biological indicators***
Sudeep Chandra	***The University of Nevada Reno***	***(775) 784−6763***	***sudeep@cabnr.unr.edu***	***biological indicators***

Michael C. Murrell ***US EPA Gulf Ecology Division*** ***(850) 934−2433*** ***murrell.michael@epa.gov*** ***adaptive management***

Executive Summary

Provide a brief but complete summary description of the proposed project; its geographic location; project objective; approach to implement the proposal; hypotheses being tested; expected outcomes; and relationship to Science Program priorities. The Executive Summary should be a concise, informative, stand−alone description of the proposed project. *(This information will be made public on our website shortly after the closing date of this PSP.)*

Estuaries form the transition zone between freshwater riverine and saline marine environments and are characterized by highly variable environmental conditions and dynamic ecosystem processes. While estuaries such as the San Francisco Estuary (SFE) receive large inputs of organic materials from upstream sources, phytoplankton (algae) provide the most important food resource for estuarine consumers such as invertebrates and fish, including highly endangered SFE species such as Delta smelt. Some phytoplankton species can also adversely affect water quality by forming harmful blooms. Algal blooms, including blooms of a potentially toxic species, have become increasingly common in the upper SFE and affect water project operations. Water resource management and ecosystem restoration conducted by CALFED and other programs in the SFE can affect phytoplankton species composition and biomass, with consequences for bloom formation, water quality, and the food web. Accurate monitoring of phytoplankton species composition and biomass is needed to maximize the positive and minimize the negative effects of phytoplankton in the SFE ecosystem, but made difficult by the highly dynamic nature of the estuarine environment and estuarine phytoplankton communities. The primary purpose of this project is to evaluate a new high−frequency method for in situ monitoring of phytoplankton biomass associated with different taxonomic groups using a submersible spectrofluorometer. This evaluation will be carried out in the laboratory with algal cultures and natural SFE samples and during stationary and vessel−based SFE field deployments of varying lengths. Most field deployments will be conducted during routine monitoring cruises and site visits. This will save travel and labor costs and provide a large amount of ancillary data and information. Secondly, this project intends to apply the spectrofluorometric method to investigations of spatial and temporal phytoplankton group distributions, monitoring design optimization, and improved ecosystem restoration and management strategies for the SFE. One important application that is expected to result from these investigations is an improved monitoring and rapid early−warning strategy for harmful algal bloom occurrences. This university−agency project will be tightly integrated with ongoing and proposed monitoring and research activities in the upper SFE and leverage substantial agency and university expertise and resources.

Give additional comments, information, etc. here.

Applicant

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All information on this page is to be provided for the agency or institution to whom funds for this proposal would be awarded.

Applicant Institution ***California Department of Water Resources*** *This list comes from the project form.*

Applicant Institution Type ***state agency***

Institution Contact

Please provide information for the primary person responsible for oversight of grant operation, management, and reporting requirements.

Salutation	***Dr.***
First Name	***Anke***
Last Name	***Mueller−Solger***
Street Address	***3251 S Street***
City	***Sacramento***
State Or Province	***CA***
ZIP Code Or Mailing Code	***95816***
Telephone	***(916)227−2194*** *Include area code.*
E−Mail	***amueller@water.ca.gov***

Additional information regarding prior applications submitted to CALFED by the applicant organization or agency and/or funds received from CALFED programs by applicant organization or agency may be required.

Personnel

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Instructions

Applicants must provide brief biographical sketches, titles, affiliations, and descriptions of roles, relevant to this effort, of the principal and supporting project participants by completing a Personnel Form. This includes the use of any consultants, subcontractors and/or vendors; provide information on this form for all such people.

Information provided on this form will automatically support subsequent forms to be completed as part of the Science PSP submission process. Please be mindful of what information you enter and how it may be represented in the Task and Budget forms.

Information regarding anticipated subcontractor services must be provided regardless if the specific service provider has been selected or not. If the specific subcontractor has not been identified or selected, please list TBD (to be determined) in the Full Name field and the anticipated service type in the Title field (example: Hydrology Expert).

Please provide this information before continuing to those forms.

Mueller−Solger, Anke B., PhD.

*This person is the **Lead Investigator**. Contact information for this person is required.*

Full Name	***Mueller−Solger, Anke B., PhD.***	example: Wright, Jeffrey R., PhD.
Institution	***California Department of Water Resources***	*This list comes from the project form.*
Title	***Staff Environmental Scientist, DWR Division of Environmental Services***	*example: Dean of Engineering*
Position Classification	***primary staff***	
Responsibilities	Project Lead − Lead, supervise, and conduct laboratory and field investigations, data management, data analyses, reporting, and project administration (Tasks 1−14)	
Qualifications		*You have already uploaded a PDF file for this question. Review the file to verify that appears correctly.*
Mailing Address	***3251 S Street***	
City	***Sacramento***	
State	***CA***	
ZIP	***95816***	
Business Phone	***(916)227−2194***	
Mobile Phone	***(916)375−1925***	
E−Mail	***amueller@water.ca.gov***	

Describe other staff below. If you run out of spaces, submit your updates and return to this form.

Goldman, Charles R., PhD.

Full Name	***Goldman, Charles R., PhD.***	example: Wright, Jeffrey R., PhD. Leave blank if name not known.
Institution	***University of California at Davis***	*This list comes from the project form.*

Title	***Full Professor of Limnology, UCD Department of Environmental Science and Policy***	*example: Dean of Engineering*
Position Classification	***primary staff***	
Responsibilities	Guide, supervise, and/or conduct laboratory and field investigations, data management, data analyses, reporting, and project synthesis (Tasks 1−3, 9, 11−13))	
Qualifications		***This is only required for primary staff.*** *You have already uploaded a PDF file for this question. Review the file to verify that appears correctly.*

Kaff, Darrell L.

Full Name	***Kaff, Darrell L.***	example: Wright, Jeffrey R., PhD. Leave blank if name not known.
Institution	***California Department of Water Resources***	*This list comes from the project form.*
Title	***Senior Control Engineer (Supervisor), DWR Division of Environmental Services***	*example: Dean of Engineering*
Position Classification	***primary staff***	
Responsibilities	Guide, supervise, assist with, and/or conduct field investigations, data management, instrument maintenance and modifications, and project synthesis (Tasks 1, 4−8, 10−13)	
Qualifications		***This is only required for primary staff.*** *You have already uploaded a PDF file for this question. Review the file to verify that appears correctly.*

Dempsey, Michael J.

Full Name	***Dempsey, Michael J.***	example: Wright, Jeffrey R., PhD. Leave blank if name not known.
Institution	***California Department of Water Resources***	*This list comes from the project form.*
Title	***Control Systems Technician, DWR Division of Environmental Services***	*example: Dean of Engineering*
Position Classification	***primary staff***	
Responsibilities	Assist with and/or conduct field investigations, instrument maintenance and modifications, and data management (Tasks 1, 4−8)	
Qualifications		***This is only required for primary staff.*** *You have already uploaded a PDF file for this question. Review the file to verify that appears correctly.*

Liston, Anne M.

Full Name	***Liston, Anne M.***	example: Wright, Jeffrey R., PhD. Leave blank if name not known.
Institution	***University of California at Davis***	*This list comes from the project form.*
Title	***Staff Research Associate II, UCD Department of Environmental Science and Policy***	*example: Dean of Engineering*

Position Classification	***primary staff***	
Responsibilities	Assist with and/or conduct laboratory investigations and analyses, maintain algal cultures, and assist with data entry and management (Tasks 1−3, 9, 10)	
Qualifications		***This is only required for primary staff.*** *You have already uploaded a PDF file for this question. Review the file to verify that appears correctly.*

TBD

Full Name	***TBD***	example: Wright, Jeffrey R., PhD. Leave blank if name not known.
Institution		*This list comes from the project form.*
Title	***Phytoplankton taxonomist***	*example: Dean of Engineering*
Position Classification	***subcontractor***	
Responsibilities	Microscopically enumerate phytoplankton samples collected during this project using a high−magnification technique. Prospective subcontractors include Richard Dufford (1845 Orchard Place, Fort Collins, CO 80521) and PhycoTech, Inc. (http://www.phycotech.com/).	
Qualifications		***This is only required for primary staff.*** *Upload a PDF version of this person's resume that is no more than five pages long. To upload a resume, use the "Browse" button to select the PDF file containing the resume.*

Santos, Eric

Full Name	***Santos, Eric***	example: Wright, Jeffrey R., PhD. Leave blank if name not known.
Institution	***California Department of Water Resources***	*This list comes from the project form.*
Title	***Chief Engineer − Fish. Vessel, DWR Division of Environmental Services***	*example: Dean of Engineering*
Position Classification	***secondary staff***	
Responsibilities	Boat Operation	
Qualifications		***This is only required for primary staff.*** *Upload a PDF version of this person's resume that is no more than five pages long. To upload a resume, use the "Browse" button to select the PDF file containing the resume.*

Conflict Of Interest

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To help Science Program staff manage potential conflicts of interest in the review and selection process, we need some information about who will directly benefit if your proposal is funded. We need to know of individuals in the following categories:

- Applicants listed in the proposal who wrote the proposal, will be performing the tasks listed in the proposal, or who will benefit financially if the proposal is funded;
- Subcontractors listed in the proposal who will perform some tasks listed in the proposal and will benefit financially if the proposal is funded.

Applicant	California Department of Water Resources
Submittor	Mueller−Solger, Anke
Primary Staff	Mueller−Solger, Anke B., PhD.
Primary Staff	Goldman, Charles R., PhD.
Primary Staff	Kaff, Darrell L.
Primary Staff	Dempsey, Michael J.
Primary Staff	Liston, Anne M.
Subcontractor	TBD
Secondary Staff	Santos, Eric

Are there other persons not listed above who helped with proposal development?
No.

If there are, provide below the list of names and organizations of all individuals not listed in the proposal who helped with proposal development along with any comments.

Tasks

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Instructions

Utilize this Task Table to delineate the tasks identified in your project description. Each task and subtask must have a number, title, brief description of the task (detailed information should be provided in the project description), timeline, list of personnel or subcontractors providing services on each specific task, and list of anticipated deliverables (where appropriate). When creating subtasks, information must be provided in a way that avoids duel presentation of supporting tasks within the overall task (i.e. avoid double counting). Information provided in the Task Table will be used to support the Budget Form. Ensuring information regarding deliverables, personnel and costs associated with subtasks are only provided once is imperative for purposes of avoiding double counting of efforts within the Budget Form.

For proposals involving multiple institutions (including subcontractors), the table must clearly state which institutions are performing which tasks and subtasks.

Task ID	Task Name	Start Month	End Month	Personnel Involved	Description	Deliverables
1	*Fluoroprobe acquisition, training, and project preparation*	*1*	*3*	***Mueller−Solger, Anke B., PhD. Goldman, Charles R., PhD. Kaff, Darrell L. Dempsey, Michael J. Liston, Anne M.***	Fluoroprobe acquisition, training, and preparations for lab and field work	Completed project set−up and FluoroProbe handling expertise
2	*Laboratory calibrations using cultures*	*1*	*9*	***Mueller−Solger, Anke B., PhD. Goldman, Charles R., PhD. Liston, Anne M.***	Laboratory Fluoroprobe calibration and testing using lab cultures of common SFE algae	FluoroProbe calibrated with algal cultures, quantitative and observational data base entries
3	*Laboratory calibrations using natural samples*	*4*	*18*	***Mueller−Solger, Anke B., PhD. Goldman, Charles R., PhD. Liston, Anne M.***	Laboratory calibrations using samples collected from 20 or more stations during the wet and dry seasons	FluoroProbe calibrated with natural samples, quantitative and observational data base entries
4	*Short−term field evaluations*	*4*	*18*	***Mueller−Solger, Anke B., PhD. Kaff, Darrell L. Dempsey, Michael J.***	Approximately 24−hour Fluoroprobe deployments at 9 or more stations conducted during the wet and dry seasons	Quantitative and observational data base entries
5	*Long−term field evaluations*	*7*	*12*	***Mueller−Solger, Anke B., PhD. Kaff, Darrell L. Dempsey, Michael J.***	Long−term Fluoroprobe deployments at 3 stations conducted during the dry season	Quantitative and observational data base entries
6	*Vessel−based deployments*	*4*	*18*	***Mueller−Solger, Anke B., PhD. Kaff, Darrell L. Dempsey, Michael J.***	Reasearch Vessel−based Fluoroprobe deployments during routine IEP monitoring cruises during the wet and dry seasons	Quantitative and observational data base entries
7	*Shallow−water and cross−channel transects*	*4*	*18*	***Mueller−Solger, Anke B., PhD.***	Vessel−based Fluoroprobe deployments along transects through shallow water habitats and across channels	Quantitative and observational data base entries

				Kaff, Darrell L. ***Dempsey, Michael J.*** ***Santos, Eric***		
8	***Frank's Tract long−term deployment***	***7***	***12***	***Mueller−Solger, Anke B., PhD.*** ***Kaff, Darrell L.*** ***Dempsey, Michael J.*** ***Santos, Eric***	Long−term Fluoroprobe deployment at station D19 in Frank's Tract conducted during the dry season	Quantitative and observational data base entries
9	***Non−routine sample analyses***	***1***	***21***	***Mueller−Solger, Anke B., PhD.*** ***Goldman, Charles R., PhD.*** ***Liston, Anne M.*** ***TBD***	Sample analyses for project samples that are not analyzed as part of routine monitoring, including 500 samples each for POC &DOC analyses and 200 phytoplankton samples for microscopic analysis	Quantitative and observational data base entries
10	***Data base, data entry, and data management***	***1***	***21***	***Mueller−Solger, Anke B., PhD.*** ***Kaff, Darrell L.*** ***Liston, Anne M.***	Data base development, data entry and data management for all project components	Project data base with public web access via the BDAT portal and supporting metadata files on the EMP website
11	***Data analysis***	***4***	***21***	***Mueller−Solger, Anke B., PhD.*** ***Goldman, Charles R., PhD.*** ***Kaff, Darrell L.***	Data analyses to test hypotheses 1−3; development of new data analysis, forecasting, and display techniques, if necessary/appropriate	Analyzed data, possibly new data analysis and display techniques
12	***Reporting of results***	***1***	***24***	***Mueller−Solger, Anke B., PhD.*** ***Goldman, Charles R., PhD.*** ***Kaff, Darrell L.***	Prepare presentations, reports, newsletter articles, peer−reviewed journal articles (as specified in proposal text)	Completed presentations, reports, newsletter articles, peer−reviewed journal articles (as specified in proposal text)
13	***Project oversight and synthesis***	***1***	***24***	***Mueller−Solger, Anke B., PhD.*** ***Goldman, Charles R., PhD.*** ***Kaff, Darrell L.***	Oversight/supervision and integration of project components	Quality assured, integrated products
14	***Project management***	***1***	***24***	***Mueller−Solger, Anke B., PhD.***	All administrative tasks related to this project, including satisfying report and contract requirements	Timely reports and budget management

Budget

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Instructions

All applicants must complete a budget for each task and subtask. The Budget Form uses data entered in the Task Form, thus tasks should be entered before starting this form. Failure to complete a Budget Form for each task and/or subtask will result in removal of the application from consideration for funding.

CBDA retains the right to request additional information pertaining to the items, rates, and justification of the information presented in the Budget Form(s).

Supporting details on how costs were derived for each line item must be included in the justification section for each item. The cost detail for each item should include the individual cost calculations associated with each line item to provide the basis for determining the total amount for each budget category.

Following are guidelines for completing the justification section of this form:

Labor (Salary &Wages)

Ensure each employee and associated classification is correctly identified for each task and subtask. This information will automatically be provided once the Staff Form has been completed. Provide estimated hours and hourly rate of compensation for each position proposed in the project.

Employee Benefits

Benefits, calculated as a percentage of salaries, are contributions made by the applicant for sick leave, retirement, insurance, etc. Provide the overall benefit rate and specify benefits included in this rate for each employee classification proposed in the project.

Travel

Travel includes the cost of transportation, subsistence, and other associated costs incurred by personnel during the term of the project. Provide purpose and estimated costs for all travel. Reoccurring travel costs for a particular task or subtask may be combined into one entry. The number of trips and cost for each occurrence must be clearly represented in the justification section for reoccurring travel items of this nature.

Any reimbursement for necessary travel and per diem shall be at rates specified by the California Department of Personnel Administration for similar employees (www.dpa.ca.gov/jobinfo/statetravel.shtm).

Equipment

Equipment is classified as any item of $5,000 or more and has an expected life of three years or more. Equipment purchased in whole or in part with these grant funds must be itemized. List each piece of equipment and provide a brief description and justification for each.

Supplies

Provide a basic description and cost for expendable research supplies. Costs associated with GIS services, air photos, reports, etc. must be listed separately and have a clear justification associated with each entry. Postage, copying, phone, fax and other basic operational costs associated with each task and subtask may be combined unless the cost associated with one particular service is unusually excessive.

Subcontractor Services

Subcontractor services (Professional and Consultant services) include the total costs for any services needed by the applicant to complete the project tasks. Ensure the correct organization is entered in the Personnel Form so that it appropriately appears on the Budget Form. The applicant must provide all associated costs of all subcontractors (i.e. outside service providers) when completing this form. Applicants must be able to demonstrate that all subcontractors were selected according to an applicant's institutional requirements for the selection of subcontractors (competitive selection or sole source justification).

CBDA retains the right to request that a subcontractor provide cost estimates in writing prior to distribution of grant funds.

CBDA retains the right to request consultant, subcontractor, and/or outside service provider cost estimates in writing prior to distribution of grant funds.

Indirect Costs (Overhead)

Indirect costs are overhead expenses incurred by the applicant organization as a result of the project but are not easily identifiable with a specific project. The indirect cost rate consists of a reasonable percentage of all costs to run the agency or organization while completing the project. List the cost and items associated with indirect costs. (These items may include general office expenses such as rent, office equipment, administrative staff, operational costs, etc. Generally these items are represented by the applicant through a predetermined percentage or surcharge separate from other specific costs of items necessary to complete a specific task or subtask.)

If indirect cost rates are different for State and Federal funds, please identify each rate and the specific items included in the calculation for that rate.

Task 1, Fluoroprobe Acquisition, Training, And Project Preparation: Labor	**Justification**	**Amount**
Mueller−Solger, Anke B., PhD.	***80 hrs, Salary supported 100% by DWR/IEP EMP***	***0***
Goldman, Charles R., PhD.	***16 hrs, Salary supported 100% by UCD Faculty Salary***	***0***
Kaff, Darrell L.	***16 hours at $42 per hour***	***672***
Dempsey, Michael J.	***16 hours at $42 per hour***	***672***
Liston, Anne M.	***16 hours at $20.68 per hour***	***331***
Task 1, Fluoroprobe Acquisition, Training, And Project Preparation: Benefits	**Justification**	**Amount**
Mueller−Solger, Anke B., PhD.	***Benefits supported 100% by DWR/IEP EMP***	***0***
Goldman, Charles R., PhD.	***Benefits supported 100% by UCD Faculty Compensation***	***0***
Kaff, Darrell L.	***0.25% of Labor Cost***	***168***
Dempsey, Michael J.	***0.25% of Labor Cost***	***168***
Liston, Anne M.	***0.36% of Labor Cost***	***119***
Task 1, Fluoroprobe Acquisition, Training, And Project Preparation: Travel Expenses	**Justification**	**Amount**
Task 1, Fluoroprobe Acquisition, Training, And Project Preparation: Supplies And Expendables	**Justification**	**Amount**
Task 1, Fluoroprobe Acquisition, Training, And Project Preparation: Subcontractors	**Justification**	**Amount**
No subcontractor was assigned to this task.		
Task 1, Fluoroprobe Acquisition, Training, And Project Preparation: Equipment	**Justification**	**Amount**
Bbe Fluoroprobe Package	***necessary instrument; price quote received 12/16/2004; no comparable instruments are offered by other manufacturers at this time***	***35000***
Task 1, Fluoroprobe Acquisition, Training, And Project Preparation: Other Direct	**Justification**	**Amount**
Task 1, Fluoroprobe Acquisition, Training, And Project Preparation: Indirect (Overhead)	**Justification**	**Amount**
Personnel	***$26 per labor hour for DWR staff, 25% for UCD staff***	***945***
	Task 1 Total	$38,075
Task 2, Laboratory Calibrations Using Cultures: Labor	**Justification**	**Amount**
Mueller−Solger, Anke B., PhD.	***160 hrs, Salary supported 100% by DWR/IEP EMP***	***0***
Goldman, Charles R., PhD.	***60 hrs, Salary supported 100% by UCD Faculty Salary***	***0***
Liston, Anne M.	***320 hours at $20.68 per hour***	***6618***
Task 2, Laboratory Calibrations Using Cultures: Benefits	**Justification**	**Amount**
Mueller−Solger, Anke B., PhD.	***Benefits supported 100% by DWR/IEP EMP***	***0***
Goldman, Charles R., PhD.	***Benefits supported 100% by UCD Faculty Compensation***	***0***
Liston, Anne M.	***0.36% of Labor Cost***	***2382***
Task 2, Laboratory Calibrations Using Cultures: Travel Expenses	**Justification**	**Amount**
Task 2, Laboratory Calibrations Using Cultures: Supplies And Expendables	**Justification**	**Amount**
Other	***UCD: Algae starter cultures and laboratory supplies***	***3000***
Task 2, Laboratory Calibrations Using Cultures: Subcontractors	**Justification**	**Amount**
No subcontractor was assigned to this task.		

Task 2, Laboratory Calibrations Using Cultures: Equipment	Justification	Amount
Task 2, Laboratory Calibrations Using Cultures: Other Direct	Justification	Amount
Task 2, Laboratory Calibrations Using Cultures: Indirect (Overhead)	Justification	Amount
Personnel	***$26 per labor hour for DWR staff, 25% for UCD staff***	***2250***
Other UCD Indirect Costs	***UCD Supplies &Analyses, 25% OH***	***750***
	Task 2 Total	$15,000
Task 3, Laboratory Calibrations Using Natural Samples: Labor	**Justification**	**Amount**
Mueller−Solger, Anke B., PhD.	***80 hrs, Salary supported 100% by DWR/IEP EMP***	***0***
Goldman, Charles R., PhD.	***20 hrs, Salary supported 100% by UCD Faculty Salary***	***0***
Liston, Anne M.	***120 hours at $20.68 per hour***	***2482***
Task 3, Laboratory Calibrations Using Natural Samples: Benefits	**Justification**	**Amount**
Mueller−Solger, Anke B., PhD.	***Benefits supported 100% by DWR/IEP EMP***	***0***
Goldman, Charles R., PhD.	***Benefits supported 100% by UCD Faculty Compensation***	***0***
Liston, Anne M.	***0.36% of Labor Cost***	***893***
Task 3, Laboratory Calibrations Using Natural Samples: Travel Expenses	**Justification**	**Amount**
Task 3, Laboratory Calibrations Using Natural Samples: Supplies And Expendables	**Justification**	**Amount**
Other	***Sampling and UCD Lab supplies (bottles, filters, chemicals, gloves, etc.)***	***500***
Task 3, Laboratory Calibrations Using Natural Samples: Subcontractors	**Justification**	**Amount**
No subcontractor was assigned to this task.		
Task 3, Laboratory Calibrations Using Natural Samples: Equipment	**Justification**	**Amount**
Task 3, Laboratory Calibrations Using Natural Samples: Other Direct	**Justification**	**Amount**
Task 3, Laboratory Calibrations Using Natural Samples: Indirect (Overhead)	**Justification**	**Amount**
Personnel	***$26 per labor hour for DWR staff, 25% for UCD staff***	***844***
Other UCD Indirect Costs	***UCD Supplies &Analyses, 25% OH***	***125***
	Task 3 Total	$4,844
Task 4, Short−Term Field Evaluations: Labor	**Justification**	**Amount**
Mueller−Solger, Anke B., PhD.	***160 hrs, Salary supported 100% by DWR/IEP EMP***	***0***
Kaff, Darrell L.	***10 hours at $42 per hour***	***420***
Dempsey, Michael J.	***50 hours at $42 per hour***	***2100***
Task 4, Short−Term Field Evaluations: Benefits	**Justification**	**Amount**
Mueller−Solger, Anke B., PhD.	***Benefits supported 100% by DWR/IEP EMP***	***0***
Kaff, Darrell L.	***0.25% of Labor Cost***	***105***
Dempsey, Michael J.	***0.25% of Labor Cost***	***525***
Task 4, Short−Term Field Evaluations: Travel Expenses	**Justification**	**Amount**
Task 4, Short−Term Field Evaluations: Supplies And Expendables	**Justification**	**Amount**
	DWR Sampling and Lab supplies (bottles, filters, chemicals, gloves, etc.)	***500***

Other		
Task 4, Short−Term Field Evaluations: Subcontractors	**Justification**	**Amount**
No subcontractor was assigned to this task.		
Task 4, Short−Term Field Evaluations: Equipment	**Justification**	**Amount**
Task 4, Short−Term Field Evaluations: Other Direct	**Justification**	**Amount**
Task 4, Short−Term Field Evaluations: Indirect (Overhead)	**Justification**	**Amount**
Personnel	***$26 per labor hour for DWR staff, 25% for UCD staff***	***1560***
	Task 4 Total	$5,210
Task 5, Long−Term Field Evaluations: Labor	**Justification**	**Amount**
Mueller−Solger, Anke B., PhD.	***80 hrs, Salary supported 100% by DWR/IEP EMP***	***0***
Kaff, Darrell L.	***10 hours at $42 per hour***	***420***
Dempsey, Michael J.	***60 hours at $42 per hour***	***2520***
Task 5, Long−Term Field Evaluations: Benefits	**Justification**	**Amount**
Mueller−Solger, Anke B., PhD.	***Benefits supported 100% by DWR/IEP EMP***	***0***
Kaff, Darrell L.	***0.25% of Labor Cost***	***105***
Dempsey, Michael J.	***0.25% of Labor Cost***	***630***
Task 5, Long−Term Field Evaluations: Travel Expenses	**Justification**	**Amount**
Task 5, Long−Term Field Evaluations: Supplies And Expendables	**Justification**	**Amount**
Other	***DWR Sampling and Lab supplies (bottles, filters, chemicals, gloves, etc.)***	***500***
Task 5, Long−Term Field Evaluations: Subcontractors	**Justification**	**Amount**
No subcontractor was assigned to this task.		
Task 5, Long−Term Field Evaluations: Equipment	**Justification**	**Amount**
Task 5, Long−Term Field Evaluations: Other Direct	**Justification**	**Amount**
Task 5, Long−Term Field Evaluations: Indirect (Overhead)	**Justification**	**Amount**
Personnel	***$26 per labor hour for DWR staff, 25% for UCD staff***	***1820***
	Task 5 Total	$5,995
Task 6, Vessel−Based Deployments: Labor	**Justification**	**Amount**
Mueller−Solger, Anke B., PhD.	***80 hrs, Salary supported 100% by DWR/IEP EMP***	***0***
Kaff, Darrell L.	***10 hours at $42 per hour***	***420***
Dempsey, Michael J.	***50 hours at $42 per hour***	***2100***
Task 6, Vessel−Based Deployments: Benefits	**Justification**	**Amount**
Mueller−Solger, Anke B., PhD.	***Benefits supported 100% by DWR/IEP EMP***	***0***
Kaff, Darrell L.	***0.25% of Labor Cost***	***105***
Dempsey, Michael J.	***0.25% of Labor Cost***	***525***
Task 6, Vessel−Based Deployments: Travel Expenses	**Justification**	**Amount**
Task 6, Vessel−Based Deployments: Supplies And Expendables	**Justification**	**Amount**
Other	***DWR Sampling and Lab supplies (bottles, filters, chemicals, gloves, etc.)***	***500***
Task 6, Vessel−Based Deployments: Subcontractors	**Justification**	**Amount**
No subcontractor was assigned to this task.		
Task 6, Vessel−Based Deployments: Equipment	**Justification**	**Amount**
Task 6, Vessel−Based Deployments: Other Direct	**Justification**	**Amount**

Task 6, Vessel−Based Deployments: Indirect (Overhead)	**Justification**	**Amount**
Personnel	***$26 per labor hour for DWR staff, 25% for UCD staff***	***1560***
	Task 6 Total	$5,210
Task 7, Shallow−Water And Cross−Channel Transects: Labor	**Justification**	**Amount**
Mueller−Solger, Anke B., PhD.	***80 hrs, Salary supported 100% by DWR/IEP EMP***	***0***
Kaff, Darrell L.	***15 hours at $42 per hour***	***630***
Dempsey, Michael J.	***34 hours at $42 per hour***	***1428***
Santos, Eric	***60 hours at $42 per hour***	***2520***
Task 7, Shallow−Water And Cross−Channel Transects: Benefits	**Justification**	**Amount**
Mueller−Solger, Anke B., PhD.	***Benefits supported 100% by DWR/IEP EMP***	***0***
Kaff, Darrell L.	***0.25% of Labor Cost***	***158***
Dempsey, Michael J.	***0.25% of Labor Cost***	***351***
Santos, Eric	***0.25% of Labor Cost***	***630***
Task 7, Shallow−Water And Cross−Channel Transects: Travel Expenses	**Justification**	**Amount**
Task 7, Shallow−Water And Cross−Channel Transects: Supplies And Expendables	**Justification**	**Amount**
Other	***DWR Sampling and Lab supplies (bottles, filters, chemicals, gloves, etc.)***	***500***
Task 7, Shallow−Water And Cross−Channel Transects: Subcontractors	**Justification**	**Amount**
No subcontractor was assigned to this task.		
Task 7, Shallow−Water And Cross−Channel Transects: Equipment	**Justification**	**Amount**
Task 7, Shallow−Water And Cross−Channel Transects: Other Direct	**Justification**	**Amount**
Task 7, Shallow−Water And Cross−Channel Transects: Indirect (Overhead)	**Justification**	**Amount**
Personnel	***$26 per labor hour for DWR staff, 25% for UCD staff***	***2834***
	Task 7 Total	$9,051
Task 8, Frank'S Tract Long−Term Deployment: Labor	**Justification**	**Amount**
Mueller−Solger, Anke B., PhD.	***40 Hrs Salary supported 100% by DWR/IEP EMP***	***0***
Kaff, Darrell L.	***10 hours at $42 per hour***	***420***
Dempsey, Michael J.	***30 hours at $42 per hour***	***1260***
Santos, Eric	***30 hours at $42 per hour***	***1260***
Task 8, Frank'S Tract Long−Term Deployment: Benefits	**Justification**	**Amount**
Mueller−Solger, Anke B., PhD.	***Benefits supported 100% by DWR/IEP EMP***	***0***
Kaff, Darrell L.	***0.25% of Labor Cost***	***105***
Dempsey, Michael J.	***0.25% of Labor Cost***	***315***
Santos, Eric	***0.25% of Labor Cost***	***315***
Task 8, Frank'S Tract Long−Term Deployment: Travel Expenses	**Justification**	**Amount**
Task 8, Frank'S Tract Long−Term Deployment: Supplies And Expendables	**Justification**	**Amount**
Other	***DWR Sampling and Lab supplies (bottles, filters, chemicals, gloves, etc.)***	***500***
	Justification	**Amount**

Task 8, Frank'S Tract Long−Term Deployment: Subcontractors		
No subcontractor was assigned to this task.		
Task 8, Frank'S Tract Long−Term Deployment: Equipment	**Justification**	**Amount**
Task 8, Frank'S Tract Long−Term Deployment: Other Direct	**Justification**	**Amount**
Task 8, Frank'S Tract Long−Term Deployment: Indirect (Overhead)	**Justification**	**Amount**
Personnel	***$26 per labor hour for DWR staff, 25% for UCD staff***	***1820***
	Task 8 Total	$5,995
Task 9, Non−Routine Sample Analyses: Labor	**Justification**	**Amount**
Mueller−Solger, Anke B., PhD.	***40 hrs, Salary supported 100% by DWR/IEP EMP***	***0***
Goldman, Charles R., PhD.	***20 hrs, Salary supported 100% by UCD Faculty Salary***	***0***
Liston, Anne M.	***400 hours at $20.68 per hour***	***8272***
Task 9, Non−Routine Sample Analyses: Benefits	**Justification**	**Amount**
Mueller−Solger, Anke B., PhD.	***Benefits supported 100% by DWR/IEP EMP***	***0***
Goldman, Charles R., PhD.	***Benefits supported 100% by UCD Faculty Compensation***	***0***
Liston, Anne M.	***0.36% of Labor Cost***	***2978***
Task 9, Non−Routine Sample Analyses: Travel Expenses	**Justification**	**Amount**
Task 9, Non−Routine Sample Analyses: Supplies And Expendables	**Justification**	**Amount**
Other	***UCD Lab supplies (bottles, filters, chemicals, gloves, etc.)***	***5000***
Task 9, Non−Routine Sample Analyses: Subcontractors	**Justification**	**Amount**
TBD	***Taxonomist for microscopic phytoplankton enumerations, 200 samples at approximately $150 per sample***	***30000***
Task 9, Non−Routine Sample Analyses: Equipment	**Justification**	**Amount**
Task 9, Non−Routine Sample Analyses: Other Direct	**Justification**	**Amount**
POC Sample Analysis	***Sample analysis by UCD Stable Isotope Facility, 1000 samples at $5 per sample***	***5000***
Task 9, Non−Routine Sample Analyses: Indirect (Overhead)	**Justification**	**Amount**
Personnel	***$26 per labor hour for DWR staff, 25% for UCD staff***	***2812***
Other UCD Indirect Costs	***UCD Supplies &Analyses, 25% OH***	***2500***
	Task 9 Total	$56,562
Task 10, Data Base, Data Entry, And Data Management: Labor	**Justification**	**Amount**
Mueller−Solger, Anke B., PhD.	***160 hrs, Salary supported 100% by DWR/IEP EMP***	***0***
Kaff, Darrell L.	***20 hours at $42 per hour***	***840***
Liston, Anne M.	***110 hours at $20.68 per hour***	***2275***
Task 10, Data Base, Data Entry, And Data Management: Benefits	**Justification**	**Amount**
Mueller−Solger, Anke B., PhD.	***Benefits supported 100% by DWR/IEP EMP***	***210***
Kaff, Darrell L.	***0.25% of Labor Cost***	***521***
Liston, Anne M.	***0.36% of Labor Cost***	***819***
Task 10, Data Base, Data Entry, And Data Management: Travel Expenses	**Justification**	**Amount**
Task 10, Data Base, Data Entry, And Data Management: Supplies And Expendables	**Justification**	**Amount**

Task 10, Data Base, Data Entry, And Data Management: Subcontractors	Justification	Amount
No subcontractor was assigned to this task.		
Task 10, Data Base, Data Entry, And Data Management: Equipment	**Justification**	**Amount**
Task 10, Data Base, Data Entry, And Data Management: Other Direct	**Justification**	**Amount**
Task 10, Data Base, Data Entry, And Data Management: Indirect (Overhead)	**Justification**	**Amount**
Personnel	***$26 per labor hour for DWR staff, 25% for UCD staff***	***773***
	Task 10 Total	$5,438
Task 11, Data Analysis: Labor	**Justification**	**Amount**
Mueller−Solger, Anke B., PhD.	***320 hrs, Salary supported 100% by DWR/IEP EMP***	***0***
Goldman, Charles R., PhD.	***40 hrs, Salary supported 100% by UCD Faculty Salary***	***0***
Kaff, Darrell L.	***20 hours at $42 per hour***	***840***
Task 11, Data Analysis: Benefits	**Justification**	**Amount**
Mueller−Solger, Anke B., PhD.	***Benefits supported 100% by DWR/IEP EMP***	***0***
Goldman, Charles R., PhD.	***Benefits supported 100% by UCD Faculty Compensation***	***0***
Kaff, Darrell L.	***0.25% of Labor Cost***	***210***
Task 11, Data Analysis: Travel Expenses	**Justification**	**Amount**
Task 11, Data Analysis: Supplies And Expendables	**Justification**	**Amount**
Task 11, Data Analysis: Subcontractors	**Justification**	**Amount**
No subcontractor was assigned to this task.		
Task 11, Data Analysis: Equipment	**Justification**	**Amount**
Task 11, Data Analysis: Other Direct	**Justification**	**Amount**
Task 11, Data Analysis: Indirect (Overhead)	**Justification**	**Amount**
Personnel	***$26 per labor hour for DWR staff, 25% for UCD staff***	***520***
	Task 11 Total	$1,570
Task 12, Reporting Of Results: Labor	**Justification**	**Amount**
Mueller−Solger, Anke B., PhD.	***480 hrs, Salary supported 100% by DWR/IEP EMP***	***0***
Goldman, Charles R., PhD.	***80 hrs, Salary supported 100% by UCD Faculty Salary***	***0***
Kaff, Darrell L.	***20 hours at $42 per hour***	***840***
Task 12, Reporting Of Results: Benefits	**Justification**	**Amount**
Mueller−Solger, Anke B., PhD.	***Benefits supported 100% by DWR/IEP EMP***	***0***
Goldman, Charles R., PhD.	***Benefits supported 100% by UCD Faculty Compensation***	***0***
Kaff, Darrell L.	***0.25% of Labor Cost***	***210***
Task 12, Reporting Of Results: Travel Expenses	**Justification**	**Amount**
Conferences	***Travel to relevant national conference to present project results***	***1000***
Task 12, Reporting Of Results: Supplies And Expendables	**Justification**	**Amount**
Task 12, Reporting Of Results: Subcontractors	**Justification**	**Amount**
No subcontractor was assigned to this task.		
Task 12, Reporting Of Results: Equipment	**Justification**	**Amount**
Task 12, Reporting Of Results: Other Direct	**Justification**	**Amount**
Task 12, Reporting Of Results: Indirect (Overhead)	**Justification**	**Amount**

Personnel	*$26 per labor hour for DWR staff, 25% for UCD staff*	*520*
	Task 12 Total	$2,570
Task 13, Project Oversight And Synthesis: Labor	**Justification**	**Amount**
Mueller−Solger, Anke B., PhD.	*100 hrs, Salary supported 100% by DWR/IEP EMP*	*0*
Goldman, Charles R., PhD.	*60 hrs, Salary supported 100% by UCD Faculty Salary*	*0*
Kaff, Darrell L.	*40 hours at $42 per hour*	*1680*
Task 13, Project Oversight And Synthesis: Benefits	**Justification**	**Amount**
Mueller−Solger, Anke B., PhD.	*Benefits supported 100% by DWR/IEP EMP*	*0*
Goldman, Charles R., PhD.	*Benefits supported 100% by UCD Faculty Compensation*	*0*
Kaff, Darrell L.	*0.25% of Labor Cost*	*420*
Task 13, Project Oversight And Synthesis: Travel Expenses	**Justification**	**Amount**
Task 13, Project Oversight And Synthesis: Supplies And Expendables	**Justification**	**Amount**
Task 13, Project Oversight And Synthesis: Subcontractors	**Justification**	**Amount**
No subcontractor was assigned to this task.		
Task 13, Project Oversight And Synthesis: Equipment	**Justification**	**Amount**
Task 13, Project Oversight And Synthesis: Other Direct	**Justification**	**Amount**
Task 13, Project Oversight And Synthesis: Indirect (Overhead)	**Justification**	**Amount**
Personnel	*$26 per labor hour for DWR staff, 25% for UCD staff*	*1040*
	Task 13 Total	$3,140
Task 14, Project Management: Labor	**Justification**	**Amount**
Mueller−Solger, Anke B., PhD.	*160 hrs, Salary supported 100% by DWR/IEP EMP*	*0*
Task 14, Project Management: Benefits	**Justification**	**Amount**
Mueller−Solger, Anke B., PhD.	*Benefits supported 100% by DWR/IEP EMP*	*0*
Task 14, Project Management: Travel Expenses	**Justification**	**Amount**
Task 14, Project Management: Supplies And Expendables	**Justification**	**Amount**
Office/Presentation Supplies	*Various office and presentation supplies*	*500*
Task 14, Project Management: Subcontractors	**Justification**	**Amount**
No subcontractor was assigned to this task.		
Task 14, Project Management: Equipment	**Justification**	**Amount**
Task 14, Project Management: Other Direct	**Justification**	**Amount**
Task 14, Project Management: Indirect (Overhead)	**Justification**	**Amount**
Personnel	*$26 per labor hour for DWR staff, 25% for UCD staff*	*0*
	Task 14 Total	$500
	Grand Total	$159,160

− The indirect costs may change by more than 10% if federal funds are awarded for this proposal.

What is the total of non−federal funds requested?

PROJECT TITLE: Phytoplankton communities in the San Francisco Estuary: monitoring and management using a submersible spectrofluorometer

EXECUTIVE SUMMARY

Estuaries form the transition zone between freshwater riverine and saline marine environments and are characterized by highly variable environmental conditions and dynamic ecosystem processes. While estuaries such as the San Francisco Estuary (SFE) receive large inputs of organic materials from upstream sources, phytoplankton (algae) provide the most important food resource for estuarine consumers such as invertebrates and fish, including highly endangered SFE species such as Delta smelt. Some phytoplankton species can also adversely affect water quality by forming harmful blooms. Algal blooms, including blooms of a potentially toxic species, have become increasingly common in the upper SFE and affect water project operations. Water resource management and ecosystem restoration conducted by CALFED and other programs in the SFE can affect phytoplankton species composition and biomass, with consequences for bloom formation, water quality, and the food web. Accurate monitoring of phytoplankton species composition and biomass is needed to maximize the positive and minimize the negative effects of phytoplankton in the SFE ecosystem, but made difficult by the highly dynamic nature of the estuarine environment and estuarine phytoplankton communities. The primary purpose of this project is to evaluate a new high-frequency method for *in situ* monitoring of phytoplankton biomass associated with different taxonomic groups using a submersible spectrofluorometer. This evaluation will be carried out in the laboratory with algal cultures and natural SFE samples and during stationary and vessel-based SFE field deployments of varying lengths. Most field deployments will be conducted during routine monitoring cruises and site visits. This will save travel and labor costs and provide a large amount of ancillary data and information. Secondly, this project intends to apply the spectrofluorometric method to investigations of spatial and temporal phytoplankton group distributions, monitoring design optimization, and improved ecosystem restoration and management strategies for the SFE. One important application that is expected to result from these investigations is an improved monitoring and rapid early-warning strategy for harmful algal bloom occurrences. This university-agency project will be tightly integrated with ongoing and proposed monitoring and research activities in the upper SFE and leverage substantial agency and university expertise and resources.

I. PROJECT PURPOSE AND BACKGROUND

A) The Importance of Phytoplankton

The base of food webs in estuaries is formed by organic materials transported into the estuaries with river flows and ocean tides and by organic materials produced in the estuaries themselves. The upstream, freshwater portions of estuaries such as the upstream portion of the San Francisco Estuary (SFE) known as the Sacramento-San Joaquin River

Delta (Delta) (Figure 1), often receive large inputs of riverine organic matter, much of which is dead detrital material. While these large amounts of detrital material of riverine origin often lead to high microbial activity and net heterotrophic metabolism in these systems, phytoplankton-produced organic matter of riverine and estuarine origin is generally more readily bioavailable and nutritious for consumers and thus fuels the consumer food web, including benthic and pelagic invertebrates and fish (Abril et al 2002). This has recently been confirmed for the Delta (Mueller-Solger et al 2002, Sobczak et al 2002 and in press). Declines seen in many zooplankton and fish species in the Delta, including the currently highly endangered Delta smelt, may be related to simultaneous declines in Delta-wide phytoplankton productivity (Jassby et al 2002). While phytoplankton tends to be more nutritious than detrital particles, the nutritional quality of phytoplankton for consumers also depends on the species composition of the phytoplankton community (Brett and Müller-Navarra 1997, Van Donk 1997, Sterner and Elser 2002, Anderssen et al 2003, Quigg 2003).

On a Delta-wide basis, phytoplankton production has decreased over the last thirty years (Jassby et al 2002), however, phytoplankton productivity and biomass in some parts of the Delta remains high (CDWR 2004) (Figure 2) and is generally thought to be regulated by local bathymetry, tidal amplitude, light availability, flows, and grazing as well as by transport-related mechanisms which regulate biomass distribution (Lucas et al 1999 and 2002, Jassby et al 2002). Excessive phytoplankton production can lead to adverse water quality conditions, including dissolved oxygen sags, taste and odor problems in drinking water, and formation of toxic or otherwise harmful algal blooms. Furthermore, algae can also interfere with the operation of water diversion and treatment operations, for example by clogging filters in water treatment plants, fish screens or channels. Finally, phytoplankton species also play an important role in the incorporation of elemental contaminants into the food web. These include several contaminants found at often high levels in the SFE, such as selenium (Riedel et al 1996, Stewart et al 2004) and mercury (Wang 2002, Wiener et al 2003). These processes and effects related to phytoplankton community composition, biomass, and production in the Delta are summarized in Figure 3.

Over the last decades, increases in harmful algal blooms (HAB) have been noted for both marine and freshwater systems (Nicholls 1995, Anderson and Garrison 1997). Often, only one or a few algal species are responsible for these adverse phenomena. Dissolved oxygen minima are commonly observed in the south-central Delta along the deep, channelized reach of the San Joaquin River leading to the Port of Stockton. These minima are at least in part related to phytoplankton blooms in the San Joaquin River and often lead to fish kills (Lehman et al 2004). Blooms of toxic cyanobacteria (blue-green algae) and dinoflagellates are increasing worldwide and along the west coast of the U.S. (Horner et al 1997, Chretiennot-Dinet 2001, Paerl et al 2001). Potentially toxic *Microcystis* sp. (cyanobacteria) blooms have been observed in the Sacramento-San Joaquin Delta in the last few years (Lehman and Waller 2003). While the exact extent, temporal dynamics, toxicity, and effects of these *Microcystis* blooms as well as the mechanisms driving them are not yet known, one could speculate that these blooms might have at least been partially responsible for the apparent year-class failure leading to the lowest Delta smelt fall midwater trawl index ever observed in 2004 (G. Castillo, USFWS, personal communication), either directly through toxic effects on certain developmental stages of Delta smelt, or indirectly through food web effects.

In addition to toxins, several algal taxa also produce taste and odor causing compounds that can affect drinking water quality (Soeder and Siegel 2000, Paterson 2004). Twenty-two million Californians rely on the Delta as a source for drinking water, most of which is pumped from the southwestern area of the Delta (Figure 1). In July of 2003 and 2004, this area experienced “taste and odor events” caused by a bloom of the cyanobacteria *Oscillatoria* sp. The Jones Tract flooding of 2004 caused additional taste and odor problems (Jeff Janik, CDWR, personal communication). Since 2003, copper sulfate has been applied near the water intake facilities to manage this problem. Of particular concern for Delta drinking water quality is also the link between the formation of harmful drinking water disinfection by-products and organic carbon concentrations resulting from phytoplankton production in the Delta and from other carbon sources. Also, blooms of some common Delta algae such as the diatom species *Melosira varians* can clog filters in water treatment facilities and the South Bay Aqueduct usually receives regular copper sulfate applications from March to September to reduce the abundance of *Melosira varians*. If Delta waters become more transparent due to reduced sediment loads as has been predicted (Jassby et al 2002), toxic, taste and odor producing, filter clogging, or otherwise harmful algal blooms may become more frequent in the Delta.

B) Phytoplankton Composition and Distribution in the SFE

Estuaries and coastal regions form the transition zone between freshwater riverine and saline marine environments. Due to the convergence of marine and riverine water, estuaries exhibit strong and often highly variable chemical, physical, and biological gradients (McLusky 1993). Along salinity gradients of estuaries, phytoplankton biomass and diversity often build up near the estuarine turbidity maximum due to tidal trapping of particles and decline in the oligo-mesohaline transition zone due to salinity stress and grazing mortality; blooms of marine species often occur at higher salinities (Muylaert and Sabbe 1999). This type of horizontal phytoplankton biomass distribution along the estuarine salinity gradient was observed in the San Francisco Estuary by Jassby et al during some of the 1995 MIDAS cruises from the Delta to South San Francisco Bay (Jassby et al 1997). Lehman (2000B) found more large phytoplankton species and diatoms at the landward than on the seaward edge of the low salinity zone.

In many turbid estuaries such as the SFE, phytoplankton production is limited by light and not nutrient availability, and phytoplankton communities are dominated by riverine and marine diatoms and low-light adapted species such as cryptophytes. Dinoflagellates, chlorophytes, and cyanobacteria are also common in estuaries (Muylaert and Sabbe 1999, Lemaire et al 2002). In the Delta, the relative diatom density decreased over the last thirty years, while the relative density of smaller green, blue-green, and flagellated algae increased (Lehman 2000A, 2004). Jassby et al (2002) found that the high amount of interannual variability in Delta-wide phytoplankton production was driven by light availability, river flows, and grazing. These authors also suggested that turbid, nutrient-rich systems such as the Delta may be more prone to high phytoplankton variability across several temporal scales than clearer, less nutrient-rich estuarine systems due to dampened compensatory processes.

In addition to its east-west salinity gradient, the Delta is also characterized by a strong productivity gradient from north to south: while unproductive, turbid Sacramento River water dominates the northern and central portions of the Delta, more productive San Joaquin River water influences its southern portion (Figure 2) (Lehman 1996, Jassby and Cloern 2000, Jassby et al 2002). Flow paths and mixing of water sources in the Delta are mainly determined by river flows, tides, and operation of State and Federal Water Projects and affect phytoplankton community composition and biomass in Delta habitats, with great variability often observed across small spatial and temporal scales and among seemingly similar habitats. For example, Lucas et al (2002) found highly variable production and distribution of phytoplankton biomass within and between two nearby flooded island habitats in the Delta (Frank's Tract and Mildred Island, see Figure 1), which they attributed to variations in phytoplankton sources, sinks, and transport. Phytoplankton biomass monitored by the EMP over a two year period at a continuous monitoring station in Stockton (P8A in Figure 1) shows seasonal and spring-neap variation (Figure 4) as well as substantial daily fluctuations (Figure 5) which can rival the magnitude of longer-term variations. These types of daily fluctuations have been observed at several sites in the Delta and upstream portions of the San Joaquin River and are likely related to daily fluctuations in algal physiology and cell division rates (Kiss 1996) and grazing (Dahlgren et al 2004, Lopez et al 2004) as well as tidal influences.

Phytoplankton production, biomass, and taxonomic composition are thus an important and highly variable determinant of water quality and the food supply for consumers in the SFE. Water resource management and ecosystem restoration conducted by the CALFED and other programs and agencies in the SFE can affect both the species composition and biomass of the phytoplankton community, with consequences for both water quality and the food web. Accurate monitoring of phytoplankton species composition and biomass is needed to (1) assess the spatial and temporal distribution of phytoplankton biomass and species in the highly dynamic SFE, including the potentially toxic *Microcystis* blooms, to (2) explore phytoplankton-related ecosystem processes; and to (3) forecast phytoplankton responses to management actions and other driving forces such as global warming. However, the challenges posed by the continuously and often rapidly changing conditions in the complex SFE combined with logistical limitations such as laborious sample analysis methods greatly affect the ability to accurately monitor phytoplankton biomass and especially phytoplankton community composition at relevant temporal and spatial scales, and new approaches to monitoring methods and design are needed.

C) Adaptive Management and Monitoring

The mission of the CALFED Bay-Delta Program is "to develop and implement a long-term comprehensive plan that will restore ecological health and improve water management for beneficial uses of the Bay-Delta System." To accomplish this, CALFED has adopted a science-based, adaptive management strategy (Figure 6) focusing on maintaining and improving ecosystem processes and functions rather than on individual system components (CBDA 2001, Healy et al 2004). To be successful, this approach requires a solid data and information base about ecosystem processes and factors driving these processes.

Large scale, long-term ecological monitoring programs such as the San Francisco Bay and Delta monitoring programs conducted over the last three decades by the San Francisco Estuary Institute (SFEI) and the California Interagency Ecological Program (IEP) and smaller-scale, shorter-term monitoring of ecosystem restoration efforts such as those supported by the CALFED program can provide much of the needed data and information (Figure 6). However, many monitoring programs focus on tracking individual system components and are often limited to low-frequency observations, or observations at small spatial and temporal scales. While often extremely informative at local scales and for answering specific questions, the data gained in such monitoring efforts are often inappropriate for elucidating and tracking ecosystem patterns and processes that span multiple spatial and temporal scales and address multiple information needs. This problem is exacerbated in highly heterogeneous systems such as the SFE, and monitoring aimed at tracking system components as well as processes across multiple scales in this system presents an ongoing challenge.

To successfully address information needs such as the need for early HAB detection and for effective performance measures for ecosystem restoration and other management activities in the SFE, monitoring programs may need to adopt an adaptive strategy similar to the adaptive management strategy put forth for ecosystem restoration. This adaptive strategy emphasizes the connection between monitoring design and information needs for ecosystem management, and aims to maximize learning about system properties and functions rather than to merely detect trends in system components (Boyle 1998, Ringold 1999). According to this ***adaptive monitoring*** scheme (Figure 7), information needs determine monitoring goals, objectives, and specific questions. Conceptual models about how to address these aims using existing knowledge about the system form the basis for designing monitoring programs. As new information becomes available, information needs, monitoring aims, conceptual models and monitoring design are constantly reviewed and, if necessary, revised, while taking care not to unnecessarily disrupt valuable long-term data streams. Targeted research to refine monitoring questions, design, and data interpretation as well as pilot monitoring efforts play an integral role in this strategy. Unfortunately, agency monitoring programs tend to have limited (or no) funds for such studies and often need to seek outside research funds, especially if costly purchases of innovative equipment or non-routine sample analyses are involved. This is the case for the study proposed here.

Since 1971, the IEP Environmental Monitoring Program (EMP, http://iep.water.ca.gov/emp/) has consistently monitored water quality constituents and lower tropic level organisms, including phytoplankton community composition and biomass, in the Delta and northern San Francisco Bay. The EMP is mandated under State Water Right Decision 1641 (D-1641) which permits the California Department of Water Resources (CDWR) and the US Bureau of Reclamation (USBR) to operate the State and Federal Water Projects. Figure 1 shows current discrete and continuous phytoplankton monitoring stations and additional D-1641 monitoring stations. Following the adaptive monitoring concept outlined above, the EMP recently underwent an in depth program review involving local experts, resource managers, and stakeholders, as well as a group of independent scientists from across the US. Reviewers investigated to what extent the EMP satisfied historical and current information needs, reformulated monitoring aims and the conceptual models forming the basis for this monitoring program, and recommended a modified monitoring design as well as a number of special studies targeted at refining the program and making better use of its large data base (IEP 2003). One of the high priority studies identified in this review concerned the spatial and temporal design of the EMP's phytoplankton monitoring element. Specifically, reviewers identified a need for conducting studies aimed at improving phytoplankton monitoring methods and providing information needed to devise a more representative, efficient phytoplankton monitoring design. The project proposed here follows directly from recommendations made by the EMP reviewers.

D) A New Phytoplankton Monitoring Method

Traditional approaches to monitoring of phytoplankton biomass and community composition include microscopic examinations of samples (Utermoehl 1958) and more recent chemical analysis techniques measuring pigments and other taxonomic markers (e.g., Lemaire et al 2002, Boscker et al 2005) in discretely collected samples. While the microscopic techniques deliver the greatest taxonomic resolution, large standard deviations are associated with estimating phytoplankton biomass from cell counts (Wilhem et al., 1991, Buchaca et al 2005). Microscopic analyses also often literally overlook small algal cells (Carrick and Schelske 1997). Pigment analysis using high pressure liquid chromatography (HPLC) delivers less taxonomic resolution but more reliable biomass conversions and has become one of the most commonly used methods for estimating and characterizing phytoplankton biomass and community composition (Llewellyn et al 2005). However, both microscopic and chemical laboratory techniques remain labor intensive (to the point of 'ruin of mind and body' through microscopic analyses according to Ernst Haeckel in 1890). Even more importantly for monitoring in dynamic systems such as the SFE, the temporal and spatial resolution of phytoplankton monitoring and studies using these techniques is necessarily limited which in turn greatly limits advances in phytoplankton ecology and management in highly dynamic systems such as estuaries. Moreover, the delay between sample collection and sample analysis prevents early detection, prediction, and effective management responses to harmful algal blooms (Schofield et al 1999, Leboulanger et al 2002). Finally, discrete sampling affords only limited ability to estimate constituent fluxes across regions of the estuary instead of merely measuring concentrations at certain locations. From a management perspective, this is particularly important for load calculations and in the context of water management in the estuary, including water project operations.

In the past two decades, optical methods to measure phytoplankton biomass and productivity from satellites, airplanes, moorings, and moving vessels have become increasingly available and reliable. These methods allow intense data collection over ecologically relevant scales (Figures 4 and 5), calculate mass fluxes, and, in combination with forecasting techniques, provide powerful tools for bloom prediction and management (Schofield 1999). Unfortunately, most of the optical instruments commonly in use today only allow for measurement of bulk phytoplankton properties without giving any information about individual taxonomic groups.

Optical distinction of different algal groups based on *in vivo* fluorescence properties has been pursued since the 1970s (e.g. Yentsch and Yentsch 1979). However, a quantitative spectrofluorometric method for measuring chlorophyll concentrations associated with different algal groups *in situ* has only recently been established (Beutler et al 2002, 2003, 2004). This method makes use of characteristic fluorescence excitation spectra for different algal "spectral classes." These group-specific "finger prints" (norm spectra) result from phylogenetic differences in accessory pigments of the light harvesting complexes. Using five diodes emitting light at 450, 525, 570, 590, and 610 nm, five spectral classes can be distinguished in mixed algal populations: "green" (chlorophyta), blue (cyanobacteria and glaucophyta), "brown" (diatoms, chrysophyta, dinophyta, haptophyta), "red" (rhodophyta and some cyanobacteria), and "mixed" (cryptophyta). Additional sensors can measure and correct for interference by colored dissolved organic matter (CDOM), turbidity, and changes in temperature. A commercially available spectrofluorometer based on this method has recently been introduced in Europe for laboratory and *in situ* applications and has been successfully employed in environmental baseline (GKSS "ferrybox," see http://coast.gkss.de/projects/ferrybox/) and harmful algal bloom monitoring (Leboulanger et al 2002) in marine and freshwater systems. This instrument, the bbe FluoroProbe (Figure 8; http://www.bbe-moldaenke.de and http://www.bbe.us/) is now also in use by several monitoring and research programs in the U.S. and Canada, including reservoir monitoring by the Metropolitan Water District (MWD) of Southern California (R. Losee, MWD, personal communication). While this type of instrument does not provide the taxonomic resolution of microscopic algal enumerations, it is capable of providing real-time data with much greater spatial and temporal resolution. A field test of the FluoroProbe conducted in the Delta in December 2002 with an instrument loaned by the manufacturer showed promising and interesting first results (Figure 8). Combined with continuous measurements of hydrodynamic and water quality variables and strategically collected discrete samples for microscopic enumeration and size-fractionated chlorophyll measurements, this type of instrument may represent a very powerful tool for ecological research and environmental monitoring. Displayed properly on the internet (such as on the GKSS ferrybox website), the data and information collected with this instrument can also be used as an effective outreach and environmental education tool.

E) Project Objectives

The primary objective of this project is to evaluate a new submersible spectrofluorometer, the bbe FluoroProbe, for phytoplankton monitoring and management in the SFE. Secondly, this project seeks to investigate high-frequency patterns in spatial phytoplankton group distributions among Delta habitats and along gradients from the productive southern Delta to the unproductive northern Delta and the increasingly saline western Delta and northern San Francisco Bay. A third aim of this project is to investigate high-frequency temporal phytoplankton patterns at fixed stations in contrasting Delta and Bay regions. We intend to use the information gained in these investigations to make recommendations for improved phytoplankton monitoring and management in the upper SFE, including recommendations for a monitoring and rapid early-warning strategy for harmful algal bloom occurrences.

II. PROJECT DESCRIPTION

A) Hypothesis Tests

Objective 1: Method and instrument evaluation

Hypothesis 1: A commercially available multispectral fluorometer, the bbe FluoroProbe, can reliably detect chlorophyll *a* concentrations of different algal taxonomic groups in cultures of SFE phytoplankton species, in natural SFE samples, and during short- and longer-term *in situ* deployments under a wide range of different environmental conditions.

a) Laboratory Calibration using Cultures (Task 2**):** To test hypothesis 1, we intend to first compare the group-specific fluorescence "fingerprints" (norm spectra) provided by the FluoroProbe manufacturer with fluorescence spectra of laboratory cultures of at least five of the dominant algal species for each of the FluoroProbe "spectral groups" in the upper San Francisco Estuary. Calibrations will follow the procedures in Leboulanger et al (2002), Beutler et al (2002) and Beutler (2003). We will also test the FluoroProbe's accuracy in detecting group-specific fluorescence signals when several of these cultures are mixed.

b) Laboratory Calibration using Natural Samples (Task 3): Chlorophyll *a* concentrations, "transmission" (turbidity) and "yellow substance" (CDOM) will be measured with the FluoroProbe and with conventional standard laboratory methods in laboratory standards and in natural water samples collected from the 20 discrete and continuous phytoplankton monitoring stations shown in Figure 1. These sites encompass the salinity and productivity gradients described above and are routinely sampled during monthly EMP monitoring cruises or routine station maintenance visits. Laboratory conditions will provide a more controlled environment for these initial tests than field deployments. For this study, samples will be collected at least once during the wet season when phytoplankton biomass is low and once during the dry season when phytoplankton biomass is higher. Samples will be transported to the UC Davis laboratory and used for calibrations and processed for discrete sample analyses as soon as possible after arrival. Microscopically determined phytoplankton densities and biovolumes will be compared with the FluoroProbe measurements. In addition to the routine phytoplankton medium-magnification enumeration method employed by the EMP, phytoplankton will also be enumerated using the high magnification technique (APHA 1998) to better account for small cells. We will also test the potential influence of several additional variables measured in the sample water on the FluoroProbe measurements, including salinity, temperature, CDOM, total suspended solids, pheophytin *a* concentrations, chlorophyll *a* size fractions, particulate and dissolved organic carbon concentrations (POC and DOC), and nutrients (for analysis methods see below).

c) Short-term field evaluations (Task 4): We will compare *in situ* total chlorophyll *a* measurements made with the FluoroProbe against similar measurements made with other simultaneously recording *in situ* chlorophyll fluorometers (Yellow Springs Instruments and Turner Designs) and with other continuous measurements including flow, stage, temperature, salinity, turbidity, dissolved oxygen, and pH at the 9 continuous stations shown in Figure 1. Deployments at each site will last at least twenty-four hours. We may also deploy the FluoroProbe alongside similar instrument packages proposed for deployment in wetlands in and surrounding the Delta, including Suisun

Marsh to the west of the Delta (Suisun Marsh Project, submitted for CALFED Science funding) and the Yolo Bypass, Liberty Island and a Cosumnes River floodplain north and east of Rio Vista (COYOTE Projects, submitted for CALFED ERP and CALFED Science funding), and other SFE wetlands (BREACH III), if funded. Collaborations may also occur with the SFEI Regional Monitoring Program (RMP), the Integrated Regional Wetlands Monitoring Program (IRWM), and the SFE National Estuarine Research Reserve (NERR). The objective is to conduct short-term side-by-side deployments of the FluoroProbe and existing continuous monitoring instrumentation in as many different estuarine environments as possible to assess its functionality across a range of salinities, temperatures, turbidity levels, CDOM concentrations, and phytoplankton biomass and community compositions. The proposed wetland monitoring sites and sites maintained by other programs would provide additional comparison opportunities without adding extra costs. Further opportunities might arise through ongoing and proposed South Delta studies (IEP-CALFED South Delta projects) and in the San Joaquin River (R. Dahlgren, UC Davis). Deployments will take place at each site once during the wet season and once during the dry season, and FluoroProbe results will be statistically compared with measurements made with the other continuous instruments and in additional grab samples collected at the beginning and the end of the deployment period. Grab sample measurements will include the same variables measured under 1b). Phytoplankton samples for microscopic enumeration collected at the beginning and at the end of each deployment will be pooled.

d) Long-term field evaluations (Task 5): We will deploy the FluoroProbe at three continuous phytoplankton monitoring sites with different productivity levels and sediment loads (stations D10, P8, and C3A) over periods of one to several weeks to evaluate its long-term recording stability and overall reliability, and potential fouling and other maintenance issues. Probe fouling by biofilms and sediment particles is a recurring problem for continuous monitoring in the San Francisco Estuary. Long-term deployments will take place during the summer and fall months. We will compare FluoroProbe maintenance requirements and data output with the requirements and data output of the other continuous instruments and investigate fouling susceptibility and maintenance strategies for the FluoroProbe. The FluoroProbe will be inspected every 2 to 4 days, and grab samples will be taken for laboratory analysis as above. Samples for phytoplankton enumeration will be combined into pooled samples spanning about one week.

e) Vessel-based deployments (Task 6): In addition to the fixed station deployments, we will also test deployment of the FluoroProbe on board of the DWR/USBR research vessels, the RV San Carlos and the RV Endeavor, during routine monthly monitoring cruises. Both vessels are equipped with continuous monitoring instrumentation similar to the continuous monitoring stations, CTD instrumentation packages used for vertical profiling, and have on-board laboratories. We will use the FluoroProbe to measure algal-group specific chlorophyll *a* levels along horizontal transects connecting the discrete sampling stations in Figure 1 (similar to the transects shown in Figures 2 and 8) and compare them with the chlorophyll and turbidity profiles recorded with the on-board (Turner) fluorometer and nephelometer. In addition, we will collect vertical chlorophyll fluorescence profiles at each discrete station (center channel) in combination with the vertical CTD drops. Vessel-based deployments will take place at least once in the dry and once in the wet season in combination with sample collection for

1b). We will compare the FluoroProbe results with continuous and grab sample (collected as above at the monitoring stations) results from these monitoring cruises. Additional discrete chlorophyll samples will be taken at three to five locations between stations to enable more statistically powerful comparisons with the FluoroProbe measurements. Also, chlorophyll *a* concentrations will be measured in discrete water samples taken with a VanDorn water sampler from discrete depths for comparison with the vertical FluoroProbe measurements.

f) Additional considerations: Bbe-moldaenke offers both a submersible multispectral fluorometer, the bbe FluoroProbe, and a flow-through benchtop model, the bbe Algae Online Analyser. For this study, we intend to purchase the FluoroProbe because of its greater versatility. We are experienced in building flow-through chambers for various submersible probes that allow bubble-free continuous immersion of probes in sample water pumped through these chambers, and intend to build and test such a chamber for the FluoroProbe. We are also currently in the process of modernizing the transmission, storage, and distribution systems used for high frequency, multiparameter data collected at continuous monitoring stations throughout the upper SFE and will explore the integration of FluoroProbe data into these systems.

g) Instrumentation, sample analyses, and algal cultures (Tasks 2-9): Details about the continuous instrumentation at the fixed monitoring stations and on the DWR/USBR research vessels can be found at http://iep.water.ca.gov/emp/Metadata/metadata_index.html. Details for station C9 can be found at http://wwwomwq.water.ca.gov/AutoStationPage/index.cfm. Routine discrete water sample analysis for the EMP is carried out by the CDWR Bryte Chemical Laboratory which strictly follows standard laboratory methods and is certified by the US EPA. Details on routine discrete water quality and phytoplankton sample analyses can be found at http://iep.water.ca.gov/emp/Metadata/metadata_index.html.

Non-routine sample analyses for this project include size-fractionated chlorophyll *a* measurements, high-magnification phytoplankton enumeration, CDOM, POC and DOC analyses. Water samples will be size fractioned using nitex screens with 30 µm and 5 µm mesh sizes to assess the contribution of nano- and pico-sized algae to total phytoplankton biomass (Carrick and Schelske 1997, Mueller-Solger et al 2002) and their possible differential impact on FluoroProbe measurements. Accurate assessment of smaller algal sizes is also the objective of the high-magnification phytoplankton enumerations which will be conducted by a subcontractor specializing in these analyses. CDOM concentrations will be determined fluorometrically using a Turner 10 AU fluorometer. POC and DOC concentrations will be analyzed by the UC Davis Stable Isotope Facility (http://stableisotopefacility.ucdavis.edu/) using published techniques (Cloern et al 2002). A side product of this project will be a comparison of the “volatile suspended solids” concentrations that have been part of the routine EMP monitoring program as a proxy for particulate organic carbon for the last three decades and POC concentrations measured during this study.

Non-routine sample preparations and some of the analyses and the study element involving algal cultures will be carried out at the UC Davis Limnology laboratory which has facilities and equipment needed for water sample analyses and for maintaining batch and continuous algal cultures, and staff experienced in various water analysis and algal culturing techniques. Starter cultures will be purchased from the Culture Collection of Algae at the University of Texas at Austin (UTEX, http://www.bio.utexas.edu/research/utex/).

h) Data handling, storage, and analysis (Tasks 10 and 11): Data collected by the FluoroProbe is initially stored and displayed using the FluoroProbe software (Figure 8). After review for accuracy, completeness, and consistency, these data will be uploaded into the continuous EMP data base and made publicly available over the internet via the BDAT portal (http://www.bdat.ca.gov). All discrete data will be stored in the discrete EMP data base and also made available on the internet via BDAT. Data flagged as "bad" are retained in local files, and notes will be added to the data base. A standard data collection sheet for noting deployment observations will be developed for the FluoroProbe and used by all project members handling the instrument. Project metadata will be entered and linked to the actual data in the data base. All project members will undergo the initial on-site training in instrument and software use offered by the manufacturer (Task 1).

For analysis of method comparison data we will use Deming regression and bias plots as described in Triboli et al (2003). Bias plots (Bland and Altman, 1999) are a graphical approach to explore how closely two methods agree (or by how much they differ) and yield a bias (= mean difference) and 95% "limits of agreement" with confidence intervals. Deming regression is a model II parametric regression technique that allows for error in both variables and statistically tests for method differences (Linnet 1998). Influences of other measured variables on FluoroProbe results will be explored using ordinary regression techniques. FluoroProbe results, especially from longer-term deployments, will also be inspected for outliers. FluoroProbe fingerprint (norm spectra) development and verification with dominant SFE algae will follow the equations in Beutler et al (2002) and Beutler (2003).

Objective 2: Spatial Distribution of Phytoplankton Groups

Hypothesis 2: The upper San Francisco Estuary can be divided into subregions and/or habitat types with distinct phytoplankton taxonomic group composition and temporal dynamics; this spatial distribution is associated with different water and phytoplankton sources, sinks, transport dynamics, and environmental conditions in these regions/habitat types.

a) Data collection: Data to test this hypothesis will come from the data collection efforts under 1b) – e) and additional data collected with the FluoroProbe along transects through shallow water habitats including Frank's Tract, Mildred Island, Sherman Lake, and Honker Bay (Figure 1) and several cross channel transects (Task 7). Shallow water habitats and channel cross-sections are historically undersampled by the EMP, but are important in assessing spatial phytoplankton distributions in this system. Shallow water areas also provide important habitat and may be sites for increased bloom development. Also, Frank's Tract is currently the focus of hydrodynamics studies aimed at water quality management in the Delta. Frank's Tract and Mildred Island were also targeted in the study of phytoplankton variability by Lucas et al (2002, see IB). Data collections will take place during the summer months when phytoplankton production is higher, and additional samples for laboratory analyses will be taken and analyzed as above.

b) Data handling, storage, and analysis (Tasks 10 and 11): All data will be handled and stored as described under objective 1. To analyze the high-resolution spatial data collected with the FluoroProbe, we will mostly use the statistical methods (including treebased modeling and multivariate techniques) described in Jassby et al. (1997) and Jassby and Cloern (2000). Also, project team members and EMP staff (Anke Mueller-Solger and Marc Vayssieres at CDWR) are currently engaged in a collaborative CALFED-funded (CALFED-ERP 2002) project focusing on regional phytoplankton biomass and production in the Delta which is led by Dr. Alan Jassby at UC Davis. Objectives of this project include using these statistical methods to evaluate phytoplankton monitoring strategies, approaches to estimating system-wide variance from discrete stations, and the relationship between system-wide variance and the number of necessary stations using existing EMP data. Other objectives are to quantitatively elucidate processes responsible for variability in phytoplankton production and related quantities and develop forecasting methods. Techniques developed and employed in this project will be immediately applicable to the FluoroProbe investigations of phytoplankton community composition described here, and this project will in effect extend the ongoing project led by Dr. Alan Jassby.

Objective 3: Temporal Distribution of Phytoplankton Groups.

Hypothesis 3: Phytoplankton taxonomic groups in the upper San Francisco Estuary vary at daily, tidal, and seasonal time scales; this temporal variability is associated with daily light and tidal fluctuations, spring-neap tide dynamics, and seasonal changes in environmental conditions, and differs between regions/habitat types.

a) Data collection: Data to test this hypothesis will come from the data collection efforts under 1b) – e) and additional data collected with the FluoroProbe in a longer-term deployment in Frank's Tract alongside continuously recording EMP instrumentation (Station D19, Figure 1) (Task 8). Frank's Tract is an important, centrally located, shallow water body in the Delta, as described above. Additional samples for laboratory analyses will be taken as above.

b) Data handling, storage, and analysis (Tasks 10 and 11): All data will be handled and stored as described under objective 1. To analyze the high-resolution temporal data collected with the FluoroProbe, we will adapt the methods described by Jassby et al (1997) to analyzing the variance in the temporal data related to daily and tidal time scales. This type of exploration is currently ongoing for the existing EMP continuous data sets in the collaboration with Alan Jassby mentioned under objective 2, and as for objective 2, techniques developed and employed in the collaborative project with Alan Jassby will be immediately applicable to the FluoroProbe investigations described here. We will also compare the temporal variability in phytoplankton groups between the wet and dry season to gain an understanding of seasonal differences.

B) Timeline

This is a two-year project. The project schedule is summarized in Table 1 and assumes a January 2006 start date. The evaluation of the new method for high-frequency, phytoplankton-group specific chlorophyll *a* measurements is the primary objective of this project. The analyses of spatial and temporal distributions of phytoplankton groups (objectives 2 and 3) are dependent on and inseparable from successful data collection under objective 1.

C) Products

(Task 12) This evaluation will result in recommendations regarding use of the FluoroProbe in SFE phytoplankton monitoring and management, including early detection of potentially harmful algal blooms. Provided that the FluoroProbe provides usable results, we will also gain new insights into spatial and temporal distributions of phytoplankton groups in the SFE which can be used in forecasting and ecosystem management applications. Results will be published in reports, including a final report integrating all aspects of the project which will include recommendations for phytoplankton monitoring and management. We will also publish shorter articles on aspects of this study in the IEP newsletter and in peer-reviewed journals. We intend to submit at least one article for publication in the online *San Francisco Estuary and Watershed Science* in which we may make use of the electronic format to include computer animations of spatial or temporal phytoplankton dynamics. We will provide all data and information collected in this project via the EMP and BDAT websites. We will also regularly inform the IEP Water Quality Project Work Team and the IEP Estuarine Ecology Teams during their ongoing bimonthly meetings and present results at regional conferences such as the CALFED Science Conference, the State of the Estuary conference, and the IEP Annual Meeting, and at the National Monitoring Conference and/or the Estuarine Research Federation's national conference. We will also informally pass project results on to other regional monitoring project staff during ongoing professional interactions. Product due dates are indicated in Table 1.

III. PROJECT JUSTIFICATION

A. Benefits to Science and Management

As described under I. and summarized in Figure 3, phytoplankton play a central role in the SFE. Of particular concern to managers may be the increasing occurrence of potentially harmful algal blooms such as the potentially toxic *Microcysti*s blooms in the central Delta (Lehmann and Waller 2003) and the taste and odor causing and filter clogging *Oscillatoria* and *Melosira* blooms in the southern Delta (Jeff Janik, CDWR, personal communication), as well as the overall decline in phytoplankton productivity in the Delta. We expect that the use of in situ optical technology to distinguish algal group contributions to total algal biomass with fine spatial and temporal resolution will significantly increase early and accurate bloom detection and the general knowledge and understanding of phytoplankton distributions, factors driving these distributions, and processes affected by these distributions in the SFE, and ultimately result in more science-based monitoring and environmental decision making.

B. Relationship to CALFED Management Priorities

This project is aimed at improving phytoplankton monitoring and management of phytoplankton-related ecosystem processes in the SFE. We expect to improve monitoring and gain a better understanding of phytoplankton-related ecosystem processes that relate to all goals of the CALFED Ecosystem Restoration Program (ERP), including management of at risk species such as the currently extremely endangered Delta smelt, management of harvestable species such a salmon, restoration of natural processes and habitats favoring a diverse phytoplankton community of good nutritional quality for consumers, reducing the impact of invasive or otherwise noxious species such as the previously rare *Microcystis*, and improving water and sediment quality, including drinking water quality in water drawn from the Delta. As outlined above, this project also touches on a large number of science and management needs, system components and processes targeted in the 2004 solicitation package for proposals to be funded by the CALFED Science Program. This includes adaptive management strategies, biological indicators, various estuarine habitats, human and ecosystem health, monitoring, natural resource management, performance measures, phytoplankton and primary productivity, trophic dynamics and food webs, water operations, and water quality management, to name only a few. As shown in Figure 6, monitoring can play a central role in CALFED's adaptive management strategy, and focused research studies such as the one proposed here are central to the ongoing adaptive optimization process of modern environmental monitoring programs (Figure 7).

C. Feasibility

This project is a collaborative effort between researchers and monitoring staff at UC Davis and CDWR. Project participants have successfully worked with each other in the past and bring a wealth of scientific and monitoring expertise to this project. Charles Goldman and Anke Mueller-Solger have been involved with conducting and administering long-term monitoring and research projects in the San Francisco Estuary, Lake Tahoe and Castle Lake in California, and around the world. Both are currently involved in CALFED-funded research projects. Anke Mueller-Solger is a regular participant in interagency and inter-institutional science and management activities, including acting as Program Co-chair for the 2004 CALFED Science Conference and working as an active member of the IEP Management Team and as chair of the IEP Water Quality Project Work Team. Anke Mueller-Solger is also fluent in German which may facilitate interactions with the FluoroProbe manufacturer in Germany. Darrell Kaff and Michael Dempsey are experts on continuous water quality monitoring instruments and applications and long-time EMP staff members. Anne Liston is highly experienced with cultures of plankton organisms, including algae, protozoa, and zooplankton, as well as laboratory analyses of natural water and plankton samples. This project will also take advantage of and extend data analyses currently underway in a collaborative CALFED-funded (CALFED-ERP 2002) project led by Alan Jassby at UC Davis (see above). Further, this project will make use of the existing monitoring infrastructure in the upper SFE, including the continuous instruments at fixed stations and on research vessels, and routine sample analyses. A complete description of stations and instruments, and sample analyses is available at http://iep.water.ca.gov/emp/Metadata/metadata_index.html. Finally, preliminary evidence from a FluoroProbe test in the Delta conducted in December 2002 holds great promise for plausible and interesting results from FluoroProbe deployments (Figure 8).

Advantages of the collaborative project proposed here include the following: (1) Enhancement of project products and resulting monitoring and management recommendations through shared understanding of the system, shared monitoring experience, and shared learning; (2) Economy of scale: this project will take full advantage of the existing monitoring infrastructure and possibly also of other monitoring efforts currently proposed for CALFED funding, which will considerably simplify project logistics and reduce field and sample analysis costs; (3) Leverages: equipment, supplies, salaries and other costs will be substantially leveraged through the existing monitoring infrastructure. Leveraged funding will also include Charles Goldman's and Anke Mueller-Solger's salaries. Charles Goldman receives a full faculty salary from UC Davis and other projects, and Anke Mueller-Solger is a staff scientist with the EMP responsible for monitoring method development and data analyses such as those described in this project. State vehicles will be used to travel to and from field sites. The value of these leveraged costs is upwards of several million dollars.

D. Equipment Justification, Project Administration, and Project Oversight

We intend to buy and test one bbe FluoroProbe for this project (Task 1). The purchase price for this instrument also includes delivery and training and is based on a price quote received 12/16/2004. The instrument will be owned by CDWR and will be used for other CDWR and interagency monitoring and research projects after the end of the proposed study. US manufacturers do not yet offer this type of instrument. If similar instruments are available from US manufacturers by the project start date, we will consider buying such an instrument instead of the bbe FluoroProbe. Project oversight will be provided by Charles Goldman of UC Davis and Anke Mueller-Solger and Darrell Kaff at DWR (Task 13). Anke Mueller Solger will also be responsible for project administration and contract management (Task 14).

E. Previously Funded Projects

An itemized budget has been entered into the CALFED PSP website. The proposed research has not been previously funded and no other sources of funding are currently being pursued. However, other sources of funding and existing monitoring infrastructure will be leveraged as described above.

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Table 1: Project time line by task, and product due dates

Task Number	**Task Name**	**Year 1**				**Year 2**			
	Season	Wet Season		Dry Season		Wet Season		Dry Season	
	Quarter	Winter (Q1)	Spring (Q2)	Summer (Q3)	Fall (Q4)	Winter (Q5)	Spring (Q6)	Summer (Q7)	Fall (Q8)
	Month	1-3	4-6	7-9	10-12	13-15	16-18	19-21	22-24
1	Fluoroprobe acquisition, training, and project prep.	■							
2	Laboratory calibrations using cultures	■	■	■					
3	Laboratory calibrations using natural samples		■	■	■	■	■		
4	Short-term field evaluations		■	■	■	■	■		
5	Long-term field evaluations			■	■				
6	Vessel-based deployments		■	■	■	■	■		
7	Shallow-water and cross-channel transects		■	■	■	■	■		
8	Frank's Tract long-term deployment			■	■				
9	Non-routine sample analyses	■	■	■	■	■	■	■	
10	Data base, data entry, and data management	■	■	■	■	■	■	■	
11	Data analysis		■	■	■	■	■	■	
12	Reporting of results	■	■	■	■	■	■	■	■
13	Project oversight and synthesis	■	■	■	■	■	■	■	■
14	Project management	■	■	■	■	■	■	■	■
Product Due Dates	Web-accessible database				■	■	■	■	■
	CALFED Quarterly Reports	■	■	■	■	■	■	■	■
	Final Project Report								■
	Presentations		■		■		■		■
	IEP Newsletter Articles				■				■
	Manuscript for peer review								■

FIGURES

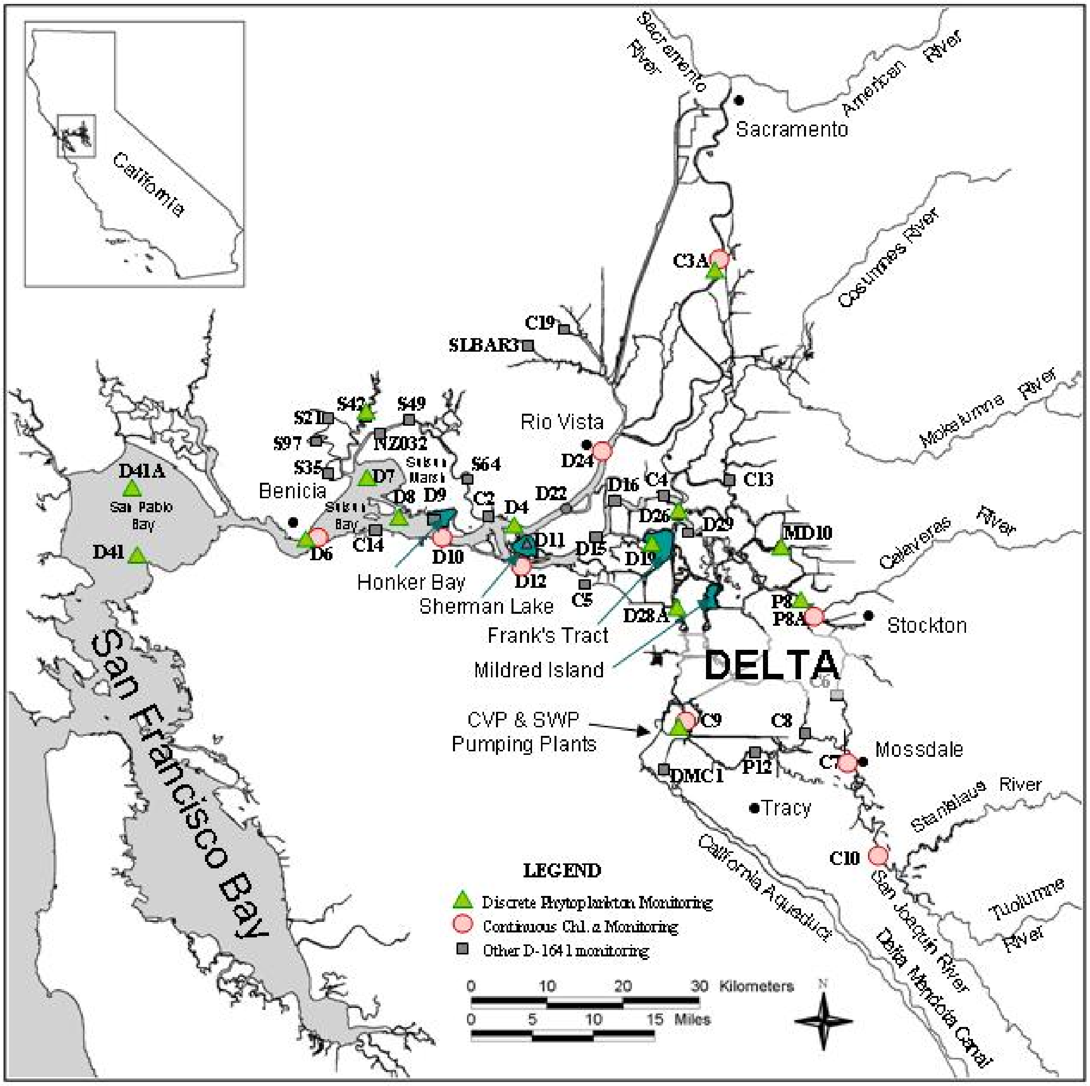

Figure 1. Discrete and continuous phytoplankton and other monitoring mandated under Water Right Decision 1641 in the upper San Francisco Estuary. Teal areas: Shallow-water habitats targeted in this study.

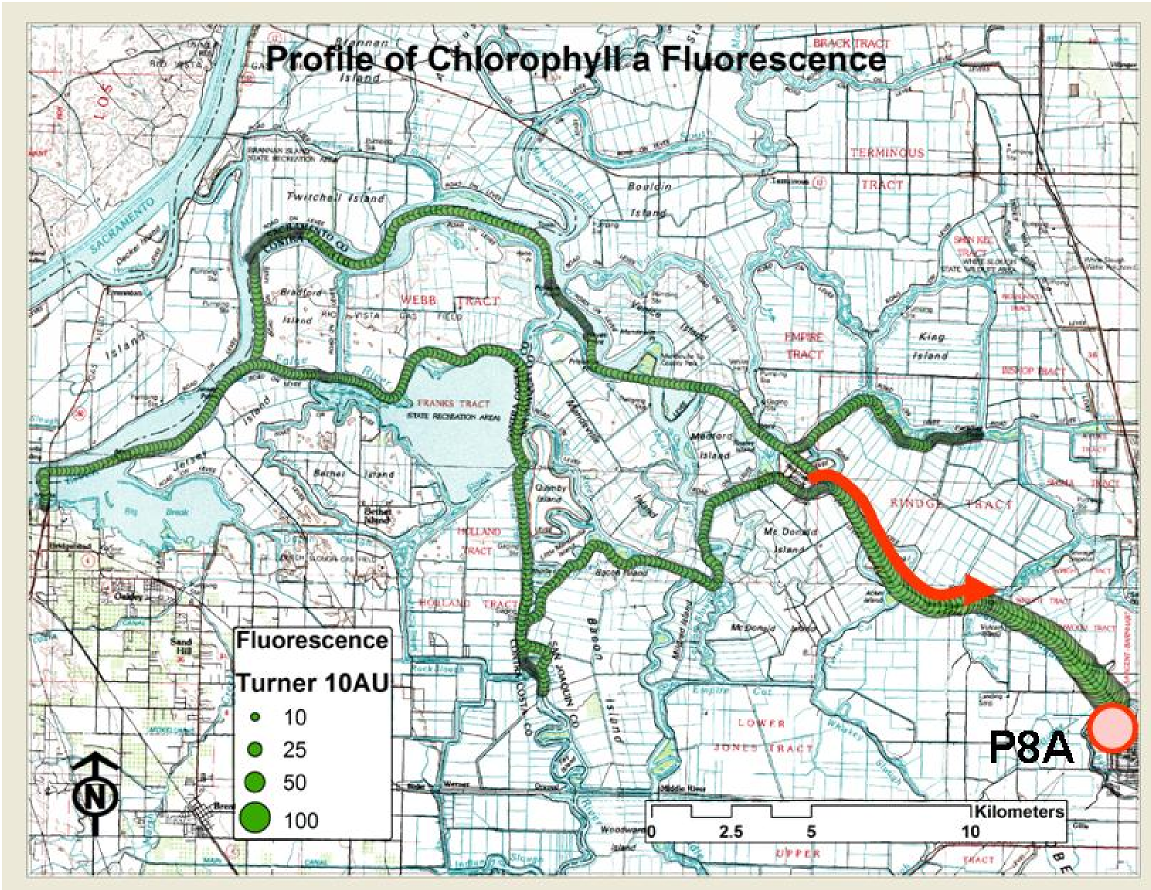

Figure 2. Results of a horizontal chlorophyll *a* fluorescence profile study conducted on December 4, 2002, on board the RV San Carlos using a Turner 10 AU fluorometer. The size of the overlapping green circles indicates the magnitude of chlorophyll fluorescence. Red arrow: location of a simultaneous FluoroProbe profile shown in Figure 8. Pink Circle: Continuous Monitoring Station P8A. Note the strong north-south gradient in chlorophyll fluorescence.

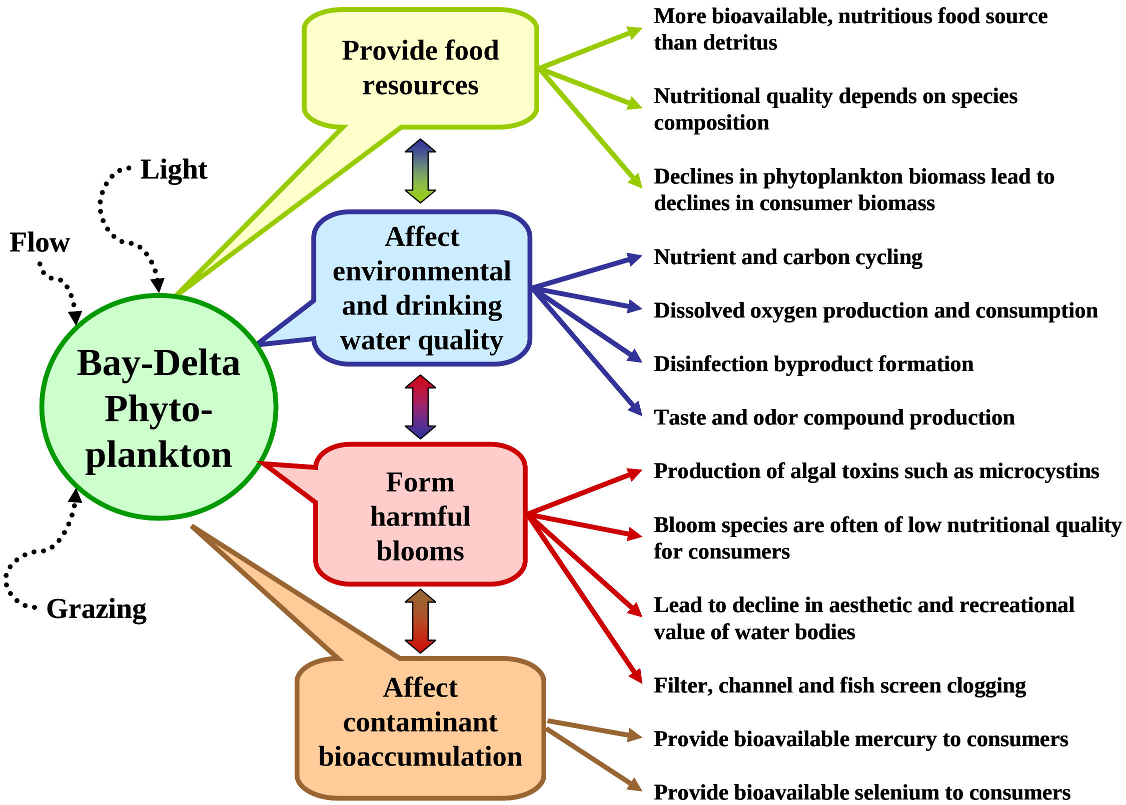

Figure 3: Summary of processes and ecosystem effects related to phytoplankton community composition and biomass in the Bay and Delta (solid, colored arrows) and factors affecting Delta phytoplankton production and biomass (broken black arrows) described in the proposal text.

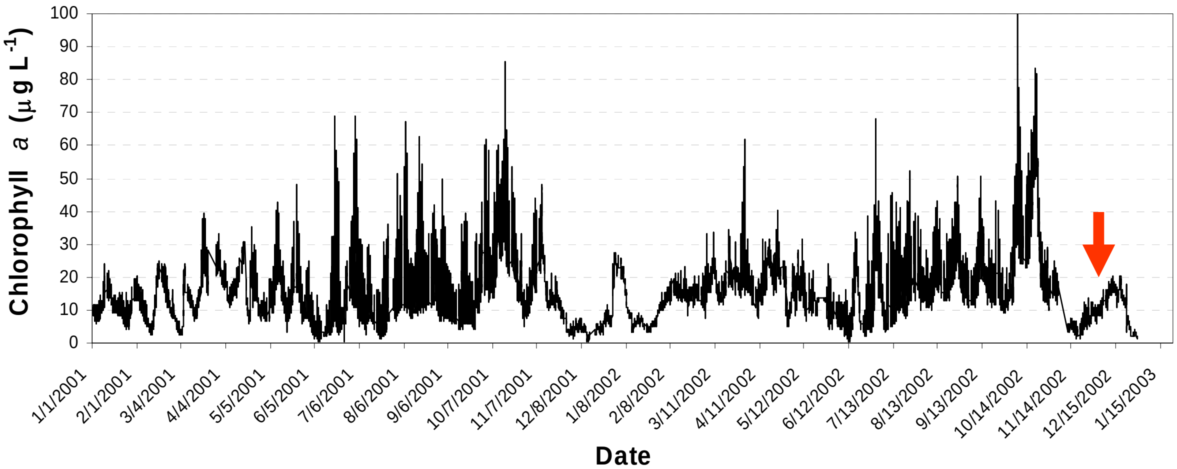

Figure 4. Time series of chlorophyll *a* concentrations measured at the continuous monitoring station P8A (Rough and Ready Island near Stockton, see Figures 1 and 2) with a Turner 10 AU fluorometer from January 2001 to December 2002. The red arrow denotes the date during which the horizontal profile studies shown in Figures 2 and 8 were conducted. Note the fortnightly (spring-neap tidal) and seasonal variations.

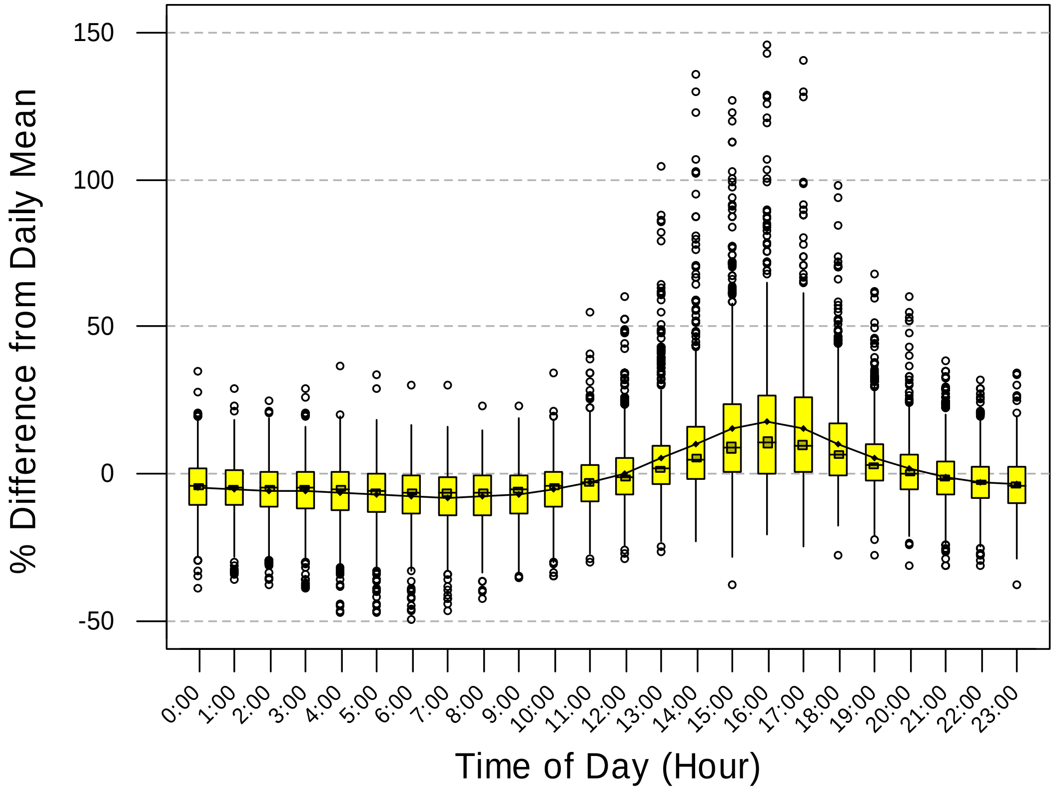

Figure 5. Box plots of diel differences between hourly and daily fluorescence means in percent of the daily mean for the chlorophyll fluorescence time series data shown in Figure 4. Note the minimum in the early morning hours and the maximum at about 4:00 pm. Also note the substantial magnitude in differences between hourly and daily means. (*Box plots*: Mean differences for each hour are connected with a line connecting the box plots and median differences are denoted with a line and an associated 95% confidence interval inside the boxes. The bottom and tops of each yellow box are the first and third quartile values, respectively. Whiskers and points outside the boxes show data that falls outside of this interquartile range.)

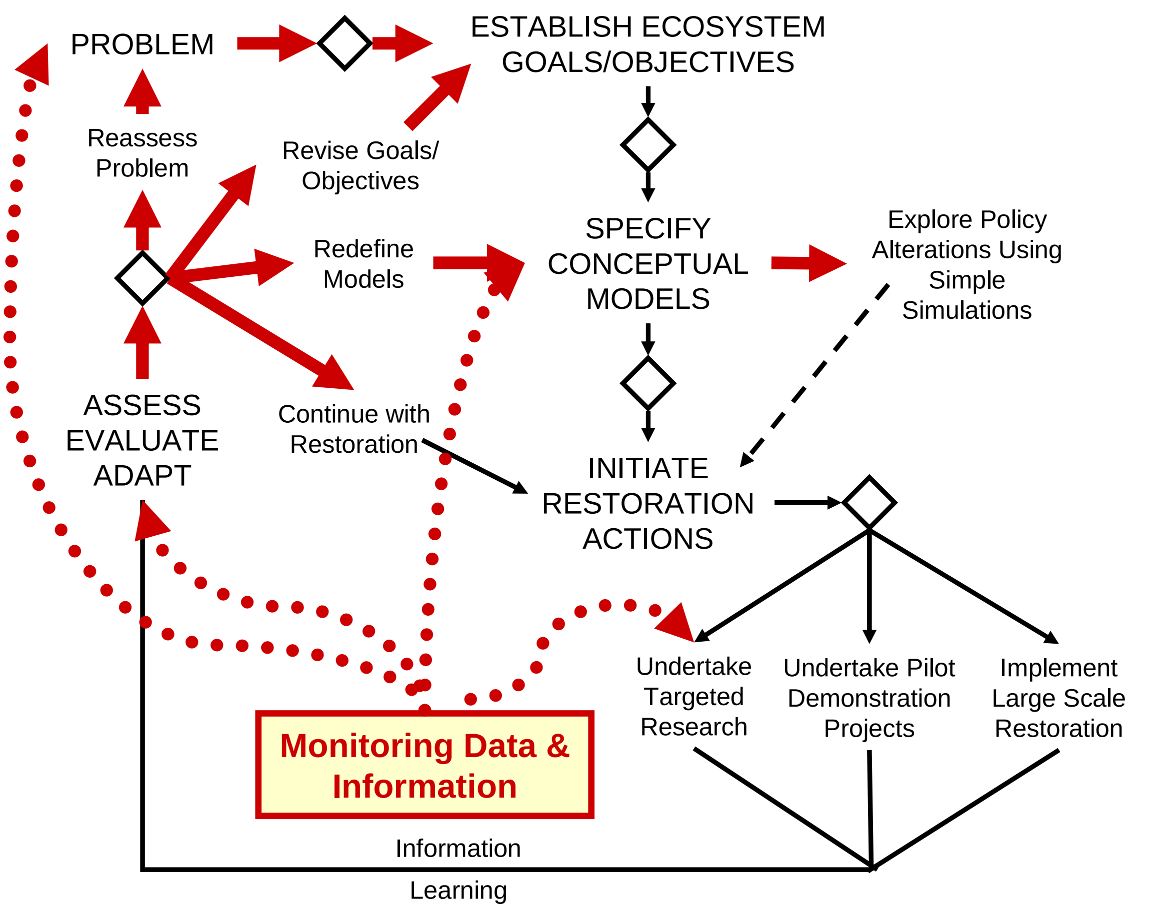

Figure 6. Adaptive management process redrawn from Figure 1 of the CALFED Draft Stage I Implementation Plan (CBDA 2001). The red broken arrows show where monitoring data and information can become part of this process and how this affects the next steps in this process (solid arrows)

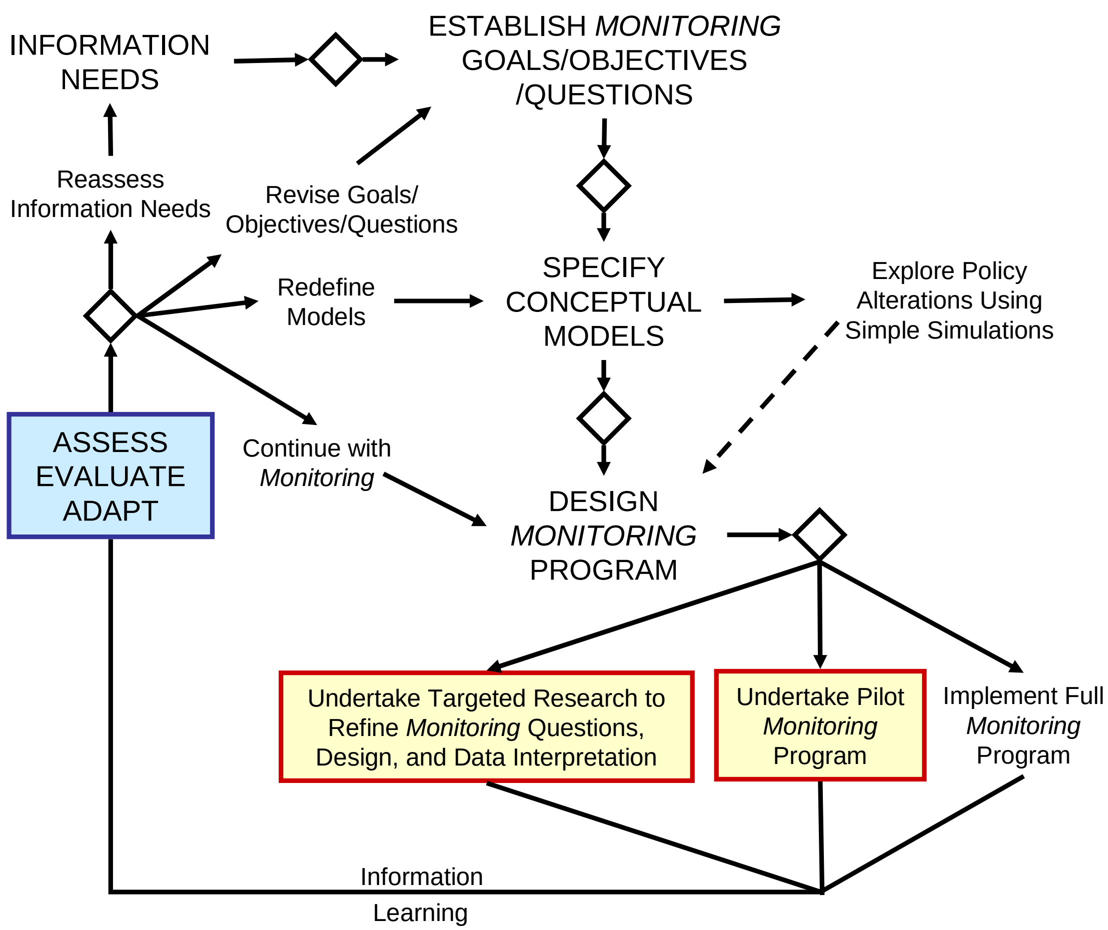

Figure 7. Adaptive monitoring process. The project proposed here falls into the two process components outlined in red (Targeted Research and Pilot Monitoring). The purpose of this project is closely aligned with the blue box.

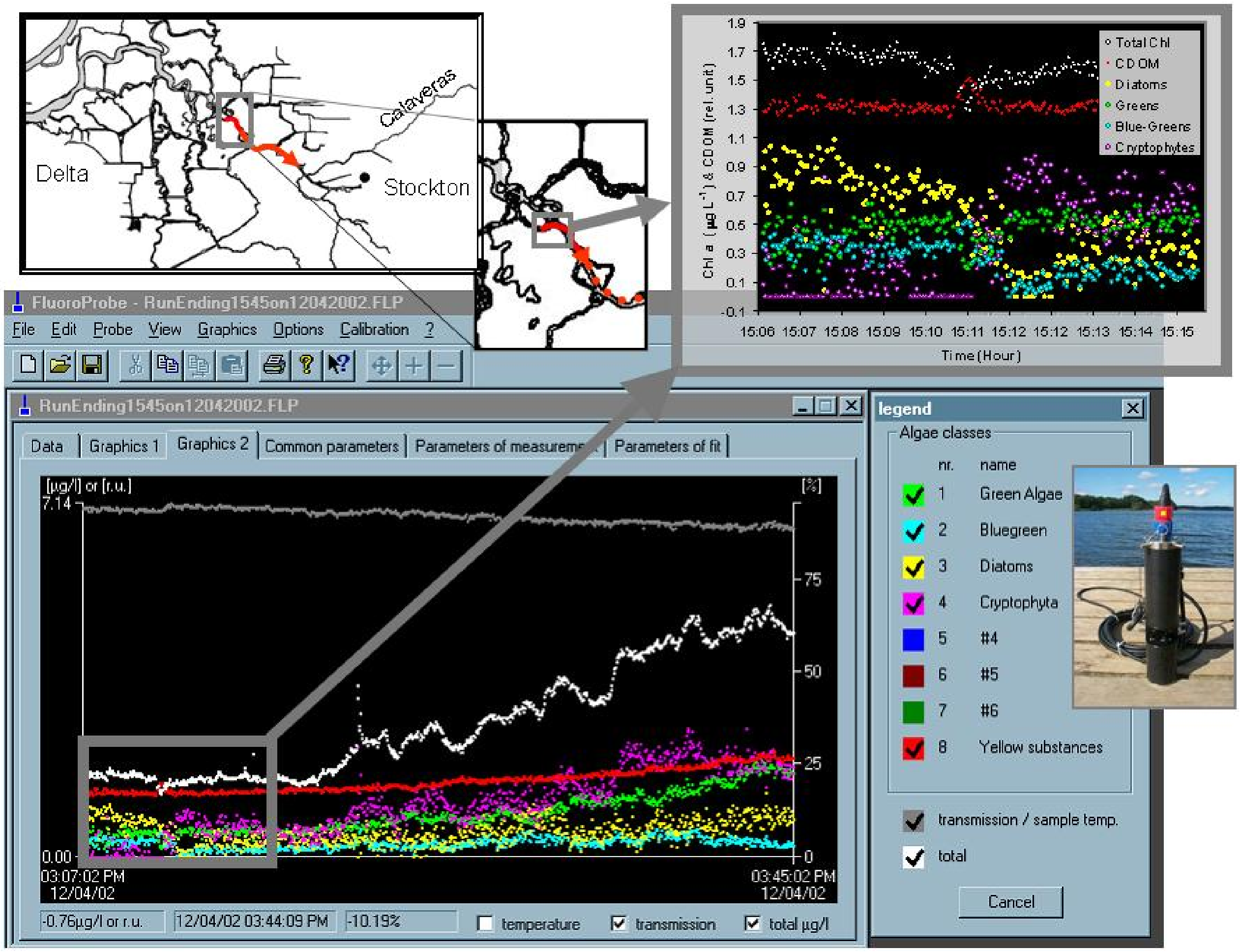

Figure 8. Results of a horizontal chlorophyll *a* fluorescence profile test deployment of the bbe FluoroProbe conducted on December 4, 2002, on board the RV San Carlos. The instrument is shown on the right. The geographic location and direction of the profile along the San Joaquin Ship Channel is shown on top (red arrow) and in Figure 2. The bottom graphic is a screen shot of results* displayed with the FluoroProbe software. Note the similarity with Figure 2 for total chlorophyll *a* fluorescence (white points). The top right graph shows the portion of the FluoroProbe data outlined by the grey box which corresponds to the small map insert. Note the abrupt change from diatom to cryptophyte dominance and the decrease in cyanobacteria (bluegreen) chlorophyll while total chlorophyll levels (initially) stayed the same. This abrupt shift in phytoplankton community composition happened as the RV San Carlos left Empire Cut and started heading up the San Joaquin Ship Channel and is likely associated with the different water sources and hydrodynamics prevailing in these areas which are affected by Delta water management. This pattern is not apparent in Figure 2 and represents the first observation of this type of abrupt change in phytoplankton composition in the Delta. Hydrodynamic studies of source water distributions have shown similar abrupt changes between source water influences at certain junctions in the Delta. Linking this type of high-resolution biological information with hydrodynamic and other water quality information may provide a powerful tool for better water and ecosystem monitoring and management.

* Chlorophyll *a* results reported in µg L^{-1}, but FluoroProbe was not calibrated, and results are really fluorescence units.

CURRICULUM VITAE
ANKE B. MUELLER-SOLGER

Department of Water Resources
Division of Environmental Services
Office of Water Quality
3251 S Street, Room C-25
Sacramento, CA 95816-7017

Phone:(916) 227-2194
Fax: (916) 227-7554
Email: amueller@water.ca.gov

EDUCATION

1998: Ph.D. (Ecology), University of California, Davis, USA
1994: M.S. (Diplom, Biology), Georg-August-University, Goettingen, Germany

PROFESSIONAL EXPERIENCE RECORD

2002 - Present: Staff Environmental Scientist, California Department of Water Resources (DWR), Division of Environmental Services
2004 - Present: Staff Research Associate, Univ. of California, Davis
2000 - 2002: Environmental Specialist/Scientist, California Department of Water Resources (DWR), Division of Environmental Services
1998-2004: Postdoctoral Scientist, Univ. of California, Davis
1993-1997: Field Director, UC Davis Castle Lake Limnological Research Laboratory

PROJECT-RELEVANT EXPERIENCE

Managed Castle Lake Long-Term Monitoring Program, 1993-1997
Broad training and experience in ecological and limnological research and monitoring with emphasis on food web dynamics and water quality
Participation in collaborative, multi-institutional projects at Castle Lake (funded by NSF) and in the San Francisco Estuary (funded by CALFED)
DWR Staff (Senior) Scientist with the IEP Environmental Monitoring Program responsible for monitoring design and method development, analyses of complex data sets, focused special studies, adaptive program reviews, and program interactions/outreach
Continued Research activities at UC Davis
Supervised undergraduate and graduate students, technicians, and a postdoctoral researcher
Engaged in many interagency and agency-university activities including active membership in the IEP Management Team, CoChair of the IEP Water Quality Project Work Team, and Program-CoChair for the 2004 CALFED Science Conference.

AWARDS AND HONORS

Co-author of a paper that received the 2004 American Society of Limnology and Oceanography (ASLO) Lindeman Award
ASLO DIALOG III Program Participant 1999
U.C. Davis Outstanding Graduate Student Teaching Award 1997-98
Various U.C. Davis Graduate Student Awards and Fellowships 1990-1998
Scholarship for Graduate Studies Abroad awarded by the German Academic Exchange Service (DAAD), Bonn, Germany, 1994-1996.

SELECTED RECENT PUBLICATIONS

Park, S., Brett, M. T., **Müller-Solger, A**., and C. R. Goldman. 2004. Climatic forcing and primary productivity in a subalpine lake: Interannual variability as a natural experiment. Limnology and Oceanography 49: 614-619.

Sommer, T.R., Harrell, W. C., **Müller Solger, A.B**., Tom, B. and W. Kimmerer. 2004. Effects of flow variation on channel and floodplain biota and habitats of the Sacramento River, California, USA. Aquatic Conservation: Marine and Freshwater Ecosystems 14: 247–261.

Schemel, L.E., Sommer, T.R., **Müller-Solger, A.B**., and W.C. Harrell. 2004. Hydrologic variability, water chemistry, and phytoplankton biomass in a large floodplain of the Sacramento River, CA, USA. Hydrobiologia 513: 129-139.

Triboli, K., **Müller-Solger, A**., and M. Vayssieres. 2003. The Grind about Sonicated Chlorophyll (or: Did a method change in 1998 affect EMP chlorophyll results?) IEP Newsletter 16: 13-25.

Jassby, A.D., Cloern, J. E., and **A. Müller-Solger**. 2003. Phytoplankton and the food web in Delta waterways. California Agriculture 57: 104-109.

Müller-Solger, A. B., A. D. Jassby, and D. C. Müller-Navarra. 2002. Nutritional quality of food resources for zooplankton (*Daphnia*) in a tidal freshwater system (Sacramento-San Joaquin River Delta, USA). Limnology and Oceanography 47:1468-1476.

Sobczak, W. V., J. E. Cloern, A. D. Jassby, and **A. B. Müller-Solger**. 2002. Bioavailability of organic matter in a highly disturbed estuary: The role of detrital and algal resources. Proceedings of the National Academy of Sciences 99: 8101-8105. (Received ASLO Lindeman Award)

Brett, M.T., F.S. Lubnow, M. Villar-Argaiz, C.R. Goldman and **A. Müller-Solger**. 1998 Nutrient control of bacterioplankton and phytoplankton dynamics. Aquatic Ecology 33: 135-145.

Müller-Solger, A., M.T. Brett, C. Luecke, J. Elser and C.R. Goldman. 1997. The effects of planktivorous fish (golden shiners) on the ciliate community of a mesotrophic lake. J. Plankton Res. 19(12):1815-1828.

OTHER QUALIFICATIONS

Professional Memberships:

American Society of Limnology and Oceanography
Estuarine Research Federation
American Geophysical Union
International Association of Theoretical and Applied Limnology

Recent Collaborators (Non-DWR And Non-UC Davis):

James Cloern, United States Geological Survey
Lawrence Schemel, United States Geological Survey
Janet Thompson, United States Geological Survey
Mary Power, UC Berkeley
William Sobczak, College of the Holy Cross
Dörthe Müller-Navarra, University of Hamburg, Germany
Michael Brett, University of Washington

Wim Kimmerer, San Francisco State University
San-Kyu Park, Korea Research Institute of Bioscience and Biotechnology

CALFED Grants and Contracts

Calfed/National Fish & Wildlife Foundation (NFWF) (co-PI/project manager)
Food resources for zooplankton in the Sacramento-San Joaquin River Delta

First-authored Conference and selected Workshop Presentations in 2004:

Müller-Solger, A.B. The base of the aquatic food web in Suisun Marsh. Oral Presentation at the CALFED Suisun Marsh Workshop, March 2004.

Müller-Solger, A.B., S.F. Kuok, K.A. Ger, E.D. Grosholz, , C.R. Goldman. Bioavailability and nutritional quality of organic matter in a Cosumnes River floodplain. Oral Presentation at the Calfed Science Conference, October 2004, Sacramento, CA.

Müller-Solger, A.B., S.F. Kuok, K.A. Ger, E.D. Grosholz, , C.R. Goldman. Bioavailability and nutritional quality of organic matter in two central California floodplains. Oral Presentation at the ASLO Summer Meeting 2004 in Savannah, GA

Müller-Solger, A.B., K. Triboli, and M, Vayssieres. Comparing monitoring methods: the grind about sonicated chlorophyll. Poster Presentation at the National Monitoring Conference 2004 in Chattanooga, TN.

CURRICULUM VITAE
CHARLES R. GOLDMAN

Department of Environmental Science and Policy
University of California, Davis
1 Shields Avenue
Davis, CA 95616

Phone: (530) 752-1557
Fax: (530)752-3938
crgoldman@ucdavis.edu

EDUCATION

B.A. (Geology), 1952, University of Illinois
M.S. (Zoology), 1955, University of Illinois
Ph.D. (Limnology-Fisheries), 1958, University of Michigan

PROFESSIONAL EXPERIENCE RECORD

45 years of research and teaching including the following:

197l - Professor of Limnology and Chairman (1987-92), Division of Environmental Studies and Department of Environmental Science and Policy; Research Limnologist and Director of Tahoe Research Group, Institute of Ecology, University of California, Davis
1966-69 Director, Institute of Ecology, University of California, Davis
1966-71 Professor of Zoology (Limnologist) University of California, Davis
1964-66 Assoc. Professor of Zoology, University of California, Davis
1960-63 Asst. Professor of Zoology, University of California, Davis
1958-60 Instructor, University of California, Davis
1957-58 Fishery Research Biologist, U.S. Fish and Wildlife Service, Alaska
1954-55 Asst. Aquatic Biologist, State Natural History Survey, Illinois
1952-54 1st Lt., U.S.A.F., Far Eastern Command (Retired Captain, U.S.A.F.)

PROJECT-RELEVANT EXPERIENCE

Long-term Director of Tahoe and Castle Lake Research Groups leading the Lake Tahoe and Castle Lake Long-Term Monitoring Programs
World-renowned, broadly experienced limnologist and ecologist
Highly experienced collaborative project leader and research grant administrator
Many public outreach activities

AWARDS AND HONORS

Guggenheim Fellow, 1965
American Association for the Advancement of Science (Fellow), 1963-present
Goldman Glacier in Antarctica named by U.S. Board on Geographic Names, 1967
Antarctic Service Medal awarded by Congress, 1968
California Academy of Science (Fellow), elected 1969
Plenary Lecture, SIL Congress, Kyoto, Japan, 1980
Elected SIL national representative, 1983-1998
Distinguished Fulbright Professorship, 1985
Abrahamsson Memorial Lecture, International Association of Astacology, 1989
R.A. Vollenweider Lecturer in Aquatic Sciences, Canadian NWRI, 1989
Senior Scientist for National Geographic Lake Baikal expedition, 1990
Culver Academies Man-of-Year Award and Chevron Conservation Award, 1991
Earle A. Chiles Award, 1992
Research Lecturer, University of California, Davis, 1993
Distinguished Public Service Award, University of California, Davis, 1993
Elected Vice President, Internat. Soc. Theoretical & Applied Limnology (SIL), 1992-98

Presented research activities to President Clinton & Vice President Gore aboard UCD-Tahoe Research Group research vessel John Le Conte, 1997
Baldi Lecture (keynote address), SIL triennial Congress, Dublin, Ireland, 1998
Laureate, 1998 Albert Einstein World Award of Science
Nevada Medal, presented by the Governor of the State of Nevada, 2003
Inaugural Distinguished Graduate Mentoring Award, UC Davis, 2003
Appointed President, World Water and Climate Network (WWCN), 2003
Alfred C. Redfield Lifetime Achievement Award, ASLO, 2004

SELECTED RECENT PUBLICATIONS

Goldman, C.R., J.J. Elser, R.C. Richards, J.E. Reuter, J.C. Priscu and A.L. Levin. 1996. Thermal stratification, nutrient dynamics, and phytoplankton productivity during the onset of spring phytoplankton growth in Lake Baikal, Russia. Hydrobiol. 331:9-24.

Brett, M.T. and C.R. Goldman. 1996. A meta-analysis of the freshwater trophic cascade. Proc. Natl. Acad. Sci. USA 93:7723-7726.

Goldman, C.R. and D.G. Slotton. 1996. Mercury contamination in California: A mining legacy, p. 145-154. *In* J.J. DeVries and J. Woled (eds.), Making the Connections: Proceedings of the 20th Biennial Ground Water Conf. Water Res. Center Report No. 88, Univ. California, Davis.

Mueller-Solger, A., M.T. Brett, C. Luecke, J. Elser and C.R. Goldman. 1997. The effects of planktivorous fish (golden shiners) on the ciliate community of a mesotrophic lake. J. Plankton Res. 19(12):1815-1828.

Brett, M.T. and C.R. Goldman. 1997. Consumer Versus Resource Control in Freshwater Pelagic Food Webs. Science 275:384-386.

Melack, J.M., J. Dozier, C.R. Goldman, D. Greenland, A.M. Milner and R.J. Naiman. 1997. Effects of climate change on inland waters of the Pacific coastal mountains and western Great Basin of North America. Hydrological Processes 11:971-992.

Goldman, C.R. 1998. Multiple environmental stresses on the fragile Lake Tahoe ecosystem, pp. 41-50. In: J.J. Cech, Jr., et al. (eds.), Multiple Stresses in Ecosystems. Lewis Publishers, CRC Press, Boca Raton, FL.

Jassby, A.D., C.R. Goldman, J.E. Reuter and R.C. Richards. 1999. Origins and scale dependence of temporal variability in the transparency of Lake Tahoe, California-Nevada. Limnol. Oceanogr. 44(2):282-294.

Jassby, A.D., C.R. Goldman, J.E. Reuter and R.C. Richards. 1999. Origins and scale dependence of temporal variability in the transparency of Lake Tahoe, California-Nevada. Limnol. Oceanogr. 44(2):282-294.

Goldman, C.R. 2000. Management-driven limnological research. Arch. Hydrobiol. Spec. Issues Advanc. Limnol. 55:257-269.

Goldman, C.R. 2000. Baldi Lecture. Four decades of change in two subalpine lakes. Verh. Internat. Verein. Limnol. 27:7-26.

Müller-Navarra, D.C., M.T. Brett, A.M. Liston and C.R. Goldman. 2000. A highly unsaturated fatty acid predicts carbon transfer between primary producers and consumers. Nature 403:74-77.

Jassby, A.D., C.R. Goldman and J.E. Reuter. 2001. Tahoe and the Delta: Some fundamental differences in conservation and restoration issues. Contributed Papers, Interagency Ecological Program Newsletter 14(3):18-22. Interagency Ecological Program for the San Francisco Estuary, http://www.iep.water.ca.gov.

Coats, R.N. and C.R. Goldman. 2001. Patterns of nitrogen transport in streams of the Lake Tahoe basin, California-Nevada. Water Resources Res. 37(2):405-415.

Goldman, C.R. and A.D. Jassby. 2001. Primary productivity, phytoplankton and nutrient status in Lake Baikal, p. 111-125. *In* M. Munawar and R.E. Hecky (eds.), The Great Lakes of the World (GLOW): Food-web, health and integrity. Backhuys Publ., Leiden, The Netherlands.

Jassby, A.D., C.R. Goldman, J.E. Reuter, R.C. Richards and A.C. Heyvaert. 2001. Lake Tahoe: Diagnosis and rehabilitation of a large mountain lake, p. 431-454. *In* M. Munawar and R.E. Hecky (eds.), The Great Lakes of the World (GLOW): Food-web, health and integrity.

Backhuys Publ., Leiden, The Netherlands.
Coats, R., F. Liu and C.R. Goldman. 2002. A Monte Carlo test of load calculation methods, Lake Tahoe basin, California-Nevada. J. American Water Resources Assoc. 38(3):719-730.
Park, S.-K., M.T. Brett, D.C. Müller-Navarra and C.R. Goldman. 2002. Essential fatty acid content and the phosphorus to carbon ratio in cultured algae as indicators of food quality for *Daphnia*. Freshwater Biology 47:1377-1390.
Park, S.-K., M.T. Brett, E.T. Oshel and C.R. Goldman. 2003. Seston food quality and *Daphnia* production efficiencies in an oligo-mesotrophic subalpine lake. Aquatic Ecology 37:123-136.
Goldman, C.R. 2003. Strategies for lake management in an increasingly global environment, p. 177-190. *In* M. Kumagai and W.F. Vincent (eds.), Freshwater Management: Global Versus Local Perspectives, Springer-Verlag, Tokyo, Japan.
Forman, R.T.T., D. Sperling, J.A. Bissonette, A.P. Clevenger, C.D. Cutshall, V.H. Dale, L. Fahrig, R. France, C.R. Goldman, K. Heanue, J.A. Jones, F.J. Swanson, T. Turrentine, T.C. Winter. 2003. Road Ecology: Science and Solutions. Island Press, Washington, DC. 481 p.
Park, S., D.C. Müller-Navarra and C.R. Goldman. 2003. Seston essential fatty acids and carbon to phosphorus ratios as predictors for *Daphnia pulex* dynamics in a large reservoir, Lake Berryessa. Hydrobiologia 505:171-178.
Jassby, A.D., J.E. Reuter and C.R. Goldman. 2003. Determining long-term water quality change in the presence of climatic variability: Lake Tahoe (USA). Can. J. Fish. Aquat. Sci. 60:1452-1461.
Park, S.-K., M.T. Brett, A. Müller-Solger and C.R. Goldman. 2004. Climatic forcing and primary productivity in a subalpine lake: interannual variability as a natural experiment. Limnol. Oceanogr. 49:614-619.
Müller-Navarra, D.C., M.T. Brett, S.-K. Park, S. Chandra, A.P. Ballantyne, A.M. Liston, and C.R. Goldman. 2004. Seston highly unsaturated fatty acid content as an indicator of food quality along a lake trophic gradient. Nature 427:69-72.

AWARDS AND HONORS

Guggenheim Fellow, 1965
American Association for the Advancement of Science (Fellow), 1963-present
Goldman Glacier in Antarctica named by U.S. Board on Geographic Names, 1967
Antarctic Service Medal awarded by Congress, 1968
California Academy of Science (Fellow), elected 1969
Plenary Lecture, SIL Congress, Kyoto, Japan, 1980
Elected SIL national representative, 1983-1998
Distinguished Fulbright Professorship, 1985
Abrahamsson Memorial Lecture, International Association of Astacology, 1989
R.A. Vollenweider Lecturer in Aquatic Sciences, Canadian NWRI, 1989
Senior Scientist for National Geographic Lake Baikal expedition, 1990
Culver Academies Man-of-Year Award and Chevron Conservation Award, 1991
Earle A. Chiles Award, 1992
Research Lecturer, University of California, Davis, 1993
Distinguished Public Service Award, University of California, Davis, 1993
Elected Vice President, Internat. Soc. Theoretical & Applied Limnology (SIL), 1992-98
Presented research activities to President Clinton & Vice President Gore aboard UCD-Tahoe Research Group research vessel John Le Conte, 1997
Baldi Lecture (keynote address), SIL triennial Congress, Dublin, Ireland, 1998
Laureate, 1998 Albert Einstein World Award of Science
Nevada Medal, presented by the Governor of the State of Nevada, 2003
Inaugural Distinguished Graduate Mentoring Award, UC Davis, 2003
Appointed President, World Water and Climate Network (WWCN), 2003
Alfred C. Redfield Lifetime Achievement Award, ASLO, 2004

OTHER QUALIFICATIONS

Synergistic Activities:

Over 100 presentations to scientific societies, agencies and organizations, 1998-2004
Presidential Environmental Forum at Lake Tahoe, 1997
US-Russia Environmental Policymakers Exchange (USA, Moscow, Irkutsk, Baikal), 1998
Development of twin 45-year long-term ecological research databases at lakes Tahoe & Castle

Graduate Advisors, University of Michigan:

K.F. Lagler, G.H. Lauff, D. Chandler, J. Moffett, L. Slobodkin

Served as Major Professor to 97 graduate students and sponsored 32 postdoctoral scientists over the past four decades at the University of California, Davis.

Collaborators (last 48 months):

B.C. Allen (UCD), M.T. Brett (UW), J.J. Elser (ASU), A.C. Heyvaert (UCD), A. Horne (UCB), D.A. Hunter (UCD), A.D. Jassby (UCD), L. Kavvas (UCD), C. Luecke (Utah State), G.J. Malyj (UCD), D. Mueller-Navarra (UCD), A. Mueller-Solger (UCD), J.E. Reuter (UCD), R.C. Richards (UCD), D. Rolston (UCD), G. Schladow (UCD), D.G. Slotton (UCD)

List of Grants and Contracts 7/1/98-present

Calfed/National Fish & Wildlife Foundation (NFWF) (co-PI)
Food resources for zooplankton in the Sacramento-San Joaquin River Delta
7/1/2001-6/30/2004; $576,422

US Geological Survey (co-PI)
Assessment of the Sacramento-San Joaquin delta as a habitat for production of the food resources that support fish recruitment
7/1/1998-6/30/2001; $384,694

National Science Foundation (co-PI)
The role of fatty acids and limiting elements in biogeochemical cycling and food web dynamics
9/1/2000-8/31/2003; $293,000

National Science Foundation (PI)
Energy flow and climate control: a program for continued long-term research at Castle Lake, CA
9/1/2000-8/31/2001; $62,001

US Geological Survey (co-PI)
Lake Tahoe Interagency Monitoring Program
10/1/1999-9/30/2004; $303,910

California State Water Resources Control Board (co-PI)
Tahoe Monitoring Program
5/1/1999-4/30/2002; $450,000

Tahoe Regional Planning Agency (co-PI)
Lake Tahoe Interagency Monitoring Program including Tahoe basin atmospheric studies
7/1/1998-6/30/2001; $260,000

Tahoe Regional Planning Agency (co-PI)
Lake Tahoe Interagency Monitoring Program
7/1/1999-6/30/2000; $110,000

Tahoe Regional Planning Agency (co-PI)
Lake Tahoe Interagency Monitoring Program
7/1/2000-6/30/2001; $110,000

Tahoe Regional Planning Agency (co-PI)
Lake Tahoe Interagency Monitoring Program
7/1/2001-6/30/2002; $110,000

Tahoe Regional Planning Agency (co-PI)
Lake Tahoe Interagency Monitoring Program
7/1/2002-6/30/2003; $110,000

Tahoe Regional Planning Agency (co-PI)
Lake Tahoe Interagency Monitoring Program
7/1/2003-6/30/2004; $110,000

Tahoe Regional Planning Agency (co-PI)
Lake Tahoe Interagency Monitoring Program
7/1/2004-6/30/2005; $110,000

U.S. Fish and Wildlife Service (co-PI)
Lahontan Cutthroat Trout study
7/1/2002-12/31/2005; $79,999

Lahontan Regional Water Quality Control Board (PI)
Tahoe basin stream water quality
1/2/2001-12/31/2001; $64,000

Placer County, California (co-PI)
Tahoe urban runoff demonstration project
6/1/2000-12/31/2002; $105,000

Nevada Tahoe Conservation District (co-PI)
Water Quality Monitoring
7/1/2001-5/31/2004; $148,972

Desert Research Institute-UNR (co-PI)
Round Hill BMP Monitoring
7/1/2001-3/1/2004; $66,605

CURRICULUM VITAE
DARRELL L. KAFF

Department of Water Resources
Division of Environmental Services
Office of Water Quality
3251 S Street, Room C-31A
Sacramento, CA 95816-7017

Phone : (916) 227-7542
Fax: (916) 227-7554
Email: dkaff@water.ca.gov

EDUCATION

1964 A.A. - Electronics Technology, California Community College, Bakersfield, California
1973 B.S. - Industrial Technology (Electronics), Long Beach State University, California, USA

PROFESSIONAL EXPERIENCE RECORD

2002 - Present: Senior Control Engineer (Supervisor), California Department of Water Resources (DWR), Division of Environmental Services
2000 – 2002: Senior Control Engineer (Supervisor): Acting Branch Chief, Systems Support Branch, Division of Operations and Maintenance, California Department of Water Resources (DWR)
1981 - 2000: Control System Technician III, Southern Field Division, California Department of Water Resources (DWR)
1973 - 1981: Control System Technician II, Southern Field Division, Californian Department of Water Resources

PROJECT-RELEVANT EXPERIENCE

As chief of the DWR Environmental Real-Time Monitoring and Support Section (2002 – Present), Project manager and supervision of:

- Design, operation and maintenance of fixed location and vessel-based continuous water quality and meteorological data collection equipment
- Continuous monitoring instrument testing and updating
- Development of real time data transmittal systems
- Data entry, QA/QC, and analyses
- Beta-testing of new instruments

Active member, IEP Water Quality Work Team (2002-Present)

Acting Branch Chief, Systems Support Branch, Division of Operations and Maintenance, California Department of Water Resources (DWR) (2000 – 2002)

As Control System Technician III, Responsible for the maintenance of all control system equipment in the Southern Field Division (6 Pumping/Generating Plants, 25 California Aqueduct Check Sites, 4 Dam/Stream Release facilities and 11 Unique Hydraulic Control Facilities and the Area Control Center of the SFD), LAN Administrator for the Southern Field Division for 7 years, included the implementation the O&M Maintenance Management Information System causing

- for the first time – the creation of Local Area Networks in all facilities throughout the Field Division and the placement of a PC on some 48 foreman/plant operator/Lead persons/Supervisors/Branch Chief's desks for their use with this application, created the Control System Equipment Hierarchy currently in use in the Plant Maintenance Module of SAP for the Field Division, Southern Field Division, California Department of Water Resources (DWR) (1981 – 2000)

As Control System Technician II, Primary responsibility for the maintenance of 14 California Aqueduct Check Sites and the Oso Pumping Plant control systems, Southern Field Division, Californian Department of Water Resources (1973 – 1981)

AWARDS AND HONORS

Unit Citation, DWR Award recognizing efforts that resulted in developing and implementing a computerized Maintenance Management Information System (MMIS) for use by the Division of Operations and Maintenance, 1989.

CURRICULUM VITAE
Michael J. Dempsey

Department of Water Resources
Division of Environmental Services
Office of Water Quality
3251 S Street, Room D-30
Sacramento, CA 95816-7017

Phone:(916) 227-7552
Fax: (916) 227-7554
Email: mdempsey@water.ca.gov

EDUCATION

1984 Electrical Engineering CSU, Sacramento

PROFESSIONAL EXPERIENCE RECORD

1990 - Present: Control Systems Technician II, California Department of Water Resources (DWR), Division of Environmental Services

1989 - 1990: Control Systems Technician I, California Department of Water Resources (DWR), Environmental Services Office

1987 - 1989: Water Resources Technician II, California Department of Water Resources (DWR), Division of Local Assistance

1985 - 1987: Water Resources Technician I, California Department of Water Resources (DWR), Central District

PROJECT-RELEVANT EXPERIENCE

Design, operation and maintenance of fixed location and vessel-based continuous water quality and meteorological data collection equipment

Continuous monitoring instrument testing and updating

Data entry, QA/QC, and analyses

Beta-testing of new instruments

Active member, IEP Water Quality Work Team

Technical workshop/conference participant and presenter. Most recently: Alliance for Coastal Technologies (ACT) Dissolved Oxygen conference held in Savannah GA, January 12- 14, 2004

CURRICULUM VITAE
ANNE M. LISTON

University of California, Davis
Dept. of Environmental Science and Policy
1 Shields Ave
Davis, CA 95616

Phone: (530)-752-0353
FAX: (530)-752-3350
Email: amliston@ucdavis.edu

EDUCATION

1996 B.S. Environmental Biology and Management, U.C. Davis

PROFESSIONAL EXPERIENCE RECORD

2003-present: Staff Research Associate II (Calfed-funded) U.C. Davis
2001-2003: Staff Research Associate II (NSF-funded) U.C. Davis
2000-2001: Post Graduate Researcher III (Calfed-funded), U.C. Davis
2000-2001: Post Graduate Researcher III (NSF-funded), U.C. Davis
1997-2000: Post Graduate Researcher I (NSF-funded), U.C. Davis
1996 Summer: Internship, U.C. Davis Castle Lake Limnological Research Laboratory

PROJECT-RELEVANT EXPERIENCE

8 years of limnological field experience in a wide variety of freshwater bodies and the San Francisco Estuary
8 years of experience with a wide variety of laboratory water quality analysis techniques, including chlorophyll, nutrient, and fatty acid analyses
6 years of experience in maintenance of laboratory cultures of plankton organisms, including batch and chemostat culturing of algae, protozoa, cladocera, and copepods
Experienced in operation and maintenance of field and laboratory instruments, including primary responsibility for a gas chromatograph used for fatty acid analyses in the UC Davis Limnological Laboratory
Experienced in data handling and analysis
Participant in collaborative, multi-disciplinary projects

PUBLICATIONS

Park, S., Brett, M.T., Müller-Navarra, D.C., Shin, S.-C., **Liston, A.M**., and C.R. Goldman. 2003. Heterotrophic nanoflagellates and increased essential fatty acids during Microcystis decay. Aquat. Microb. Ecol. 33: 201-205.

Müller-Navarra, D.C., Brett, M.T., **Liston, A.M**., and C.R. Goldman. 2000. A highly-unsaturated fatty acid predicts carbon transfer between primary producers and consumers. Nature 403: 74-77.

Phytoplankton Communities In The San Francisco Estuary: Monitoring And Management Using A Submersible Spectrofluorometer: Signature

This proposal is for the Science Program 2004 solicitation as prepared by Mueller-Solger, Anke .

> The submission deadline is approximately 20 hours from now.
>
> Proposal updates will be disabled immediately after the deadline. All forms, including the signature form, must be completed, compiled and acknowledged in order to be eligible for consideration and review. Allow at least one hour for Science Program staff to verify and file signature pages after they are received.

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

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 confidentiality1 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: Phytoplankton communities in the San Francisco Estuary: monitoring and management using a submersible spectrofluorometer

Proposal Number: 2004.01-0332

A. Müller-Solger 12-5-04

Applicant Signature **Date**

ANKE B. MUELLER-SOLGER DEPARTMENT OF WATER RESOURCES

Printed Name Of Applicant **Applicant Organization**

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/2004.01/proposals/0332/forms/60?form_read_only=1
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