Do Low Phytoplankton Growth Rates Signal The “Bad” Habitat Conditions In Susiun Bay Driving The Pelagic Organism Decline

submitted to Science Program 2006

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lead investigators:
Dugdale, Richard
Wilkerson, Frances

Project Information And Executive Summary

Do Low Phytoplankton Growth Rates Signal The “Bad” Habitat Conditions In Susiun Bay Driving The Pelagic Organism Decline

This is proposal #0065 for the Science Program 2006 solicitation.

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

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

Instructions

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

Proposal Title: **Do Low Phytoplankton Growth Rates Signal the “Bad” Habitat Conditions in Susiun Bay Driving the Pelagic Organism Decline**

This field is limited to 255 characters. All proposal titles must be entered in title case. No abbreviations or acronyms will be accepted.

Applicant Information

Applicant Organization Name: **San Francisco State University**

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

Applicant Organization Type:
public institution of higher education

eligibility

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

Salutation: **Dr**
First Name: **Kenneth**
Last Name: **Paap**
Street Address: **1600 Holloway Avenue, SFSU, ADM 469**
City: **San Francisco**
State or Province: **CA**
Zip Code or Mailing Code: **94132**
Telephone: **415−338−7091**
E−mail Address: **kenp@sfsu.edu**

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

Salutation: **Dr**
First Name: **Richard**
Last Name: **Dugdale**
Telephone: **415 435 7140**
E−mail Address: **rdugdale@sfsu.edu**

Proposal Information

Total Amount Requested: $605,751

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

this project.

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

Habitat Availability and Response to Change (Primary)

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

Aquatic Invasive (Exotic) Species

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

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

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

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

Help for finding a geographic location.

Latitude: **38.05**
Longitude: **−122.1**

Provide the number miles radius from the center point provided above, to demonstrate the radius of the entire project.
34

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

Central Bay off RTC Suisun Bay Sacramento River up to Rio Vista San Joaquin River up to Jersy Point (JPT) site.

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

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

not applicable

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

If yes, identify the ongoing project:

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

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

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

Project Title: **Foodweb support for the threatened delta smelt and other etsuarine fishes in Suisun bay and the western Sacramento–San Joaquin Delta**
CALFED Contract Management Organization: **RTC/SFSU**
Amount Funded: **$1,170,000**
Date Awarded: **1/1/06**
Lead Organization: **SFSU (Kimmerer)**
Project Number: **Science Program Project No. SCI–05–C107**

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

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

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

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

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

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

Project Title:
CALFED Program:
Date of PSP:

Project Title:
CALFED Program:
Date of PSP:

Project Title:
CALFED Program:
Date of PSP:

Project Title:
CALFED Program:
Date of PSP:

Project Title:
CALFED Program:
Date of PSP:

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

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

Full Name	Organization	Telephone	E−Mail	Expertise
Jonathan Sharp	Univeristy of Delaware	302 645 4259	jsharp@udel.edu	
Ted Smayda	University of Rhode Island		tsmayda@gso.uri.edu	
Hans Paerl	Univ. North Carolina		hpaerl@email.unc.edu	

Provide additional comments, information, etc. here:

Executive Summary

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

Do Low Phytoplankton Growth Rates Signal the “Bad” Habitat Conditions in Suisun Bay Driving the Pelagic Organism Decline?

EXECUTIVE SUMMARY

We propose a study of the anomalous low phytoplankton productivity in Suisun Bay by comparing Suisun Bay phytoplankton growth and nutrient uptake rates with those in Central San Francisco Bay, the Delta and the Sacramento and San Joaquin Rivers and using mesocosms to evaluate causal drivers. Recent declines in pelagic fishes in the upper SF Estuary (the Delta and Suisun Bay) and the need to understand the underlying causes resulted in the formation of a Pelagic Organism Decline (POD) project work team by the Interagency Ecological Program. One of their explanations was the Bad Suisun Bay Hypothesis which focuses on food web effects in Suisun Bay and the western Delta, and is directly addressed by this proposal. As such the research considers a priority research area for CALFED Science Program, the POD. More specific to this solicitation, we address Priority Topic 4: Habitat Availability and Response to Change and all the associated questions, by proposing to learn more about the quality of the Delta habitat for key species, the “bad” drivers that are responsible and using modeling to assess how change will affect habitat conditions at the food web level. Our studies have shown that conditions in Suisun Bay are far less favorable for phytoplankton than in San Pablo and Central Bays, with reduced nutrient uptake capacity and growth rates that results in low primary production and chlorophyll accumulation. Other stressors (e.g. Corbula grazing) will modulate the chlorophyll biomass. The combination of low biomass and growth rates results in much reduced production of quality phytoplankton food for higher trophic levels. We have used experimental mesocosms to test how SFE water (without resident phytoplankton) influences the growth of a phytoplankton inoculum and observed that they do not grow in Suisun Bay water whereas they will in Central and San Pablo Bay water. These observations support the idea that there is something “bad” about the water in Suisun Bay and led us to

ask 1) is the “bad” habitat for phytoplankton in Suisun Bay an anomalous condition or part of a continuum between freshwater and oceanic systems? 2) what drivers contribute to the low growth rates in Suisun Bay and how well can the phytoplankton recover when these are removed or changed? 3) if Suisun and Delta phytoplankton are encouraged to grow in near natural conditions, which phytoplankton members of the community respond? What is the underlying physiological mechanism? and 4) Can a management approach be identified from the answers to alleviate the diminished food sources linked to the POD? Our simple conceptual model for the Suisun habitat uses phytoplankton to signal the “bad” conditions. Our hypothesis is that Suisun is an anomalous estuarine habitat in which inhibitory effects on physiology result in little chlorophyll of poor food quality for the Delta food web. Removal of the “bad” factors should switch the growth and community structure towards the better quality phytoplankton that occurs in Central Bay. The scope of work includes an administrative task, a fieldwork based task to describe the “bad” Suisun habitat in context of upstream and downstream, an experimental task using mesocosms to manipulate possible drivers causing this habitat, a taxonomic task to determine the phytoplankton community structure (food quality) and a modeling task to simulate the effect of change and determine if management practices aimed at this trophic level are feasible. Our expected outcomes are a test of the Bad Suisun Bay Hypothesis and evaluation of possible adaptive management approaches to alleviate the POD.

Contacts And Project Staff

This is proposal #0065 for the Science Program 2006 solicitation.

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

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INSTRUCTIONS

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

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

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

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

Applicant

San Francisco State University
Dr Kenneth Paap
1600 Holloway Avenue, SFSU, ADM 469
San Francisco CA 94132
415−338−7091
kenp@sfsu.edu

Lead Investigator/Project Director

Salutation: **Dr**
Last Name: **Dugdale**
First Name: **Richard**
Title: **Senior Research Scientist**
Organization: **Romberg Tiburon Center, San Francisco State University**
Responsibilities: **Manage project (Task1).Oversee all scientific tasks (Tasks 2,3,4,5). Participate in cruises, mesocosms, lab analyses and data workup. Give scientific presentations and prepare manuscripts. Carry out Modeling (Task5)**
Resume:

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

Mailing Address: **3152 Paradise Drive**
City: **Tiburon**
State: **CA**
Zip: **94920**
Telephone: **415 435 7140**
E−Mail: **rdugdale@sfsu.edu**

All Other Personnel

Salutation: **Dr**
Last Name: **Wilkerson**
First Name: **Frances**
Title: **Senior Research Scientist**

Organization: **Romberg Tiburon Center, San Francisco State University**
Position:
Co-PI
Responsibilities: **Has management responsibilities for all tasks, especially in the area of report preparation and submittal of CALFED deliverables (Task 1). Participate in mesocosms, lab analyses and data workup. Give scientific presentations and prepare manuscripts. Mentor graduate student**
Qualifications:

FRANCES P WILKERSON Romberg Tiburon Center, San Francisco State University, 3152 Paradise Drive, Tiburon, CA 94920 Phone (work) 415-338 3519, (fax) 435 7120 (home) 415-945 1306 Email fwilkers@sfsu.edu

CURRENT POSITION: Senior Research Scientist, Romberg Tiburon Center Lecturer &Adjunct Professor, Dept. Biology, SFSU EDUCATION 1977 B.A. Natural Sciences (Honors), University of Cambridge, U.K. 1980 M.A. Natural Sciences, University of Cambridge, U.K. 1980 Ph.D. Botany, University of Bristol, U.K., Advisor: Sir David C. Smith F.R.S.

POSITIONS HELD 1996- Senior Research Scientist, Lecturer and Adjunct Prof. SFSU 1996 Associate Research Professor, Dept Biological Sciences, USC 1989-96 Assistant Research Professor, Dept Biological Sciences, USC 1984-89 Research Associate, Allan Hancock Foundation, University of Southern California

SELECTED RECENT PUBLICATIONS Dugdale, R.C., F.P. Wilkerson, V.E. Hogue and A. Marchi. 2007. Spring phytoplankton bloom development in San Francisco Estuary: the role of ammonium and nitrate. In revision to Estuarine, Coastal and Shelf Science Wilkerson, F.P. R.C. Dugdale, A. Marchi, V. Hogue, A. Lassiter. 2007. The phytoplankton bloom response to wind events and upwelled nutrients during the CoOP-WEST Study. In press. Deep-Sea Research II Lassiter, A.M, F. Wilkerson, R.Dugdale and V. Hogue. Functional phytoplankton groups in the CoOP-West upwelling region: the Chaeteoceros complex. In press. Deep-Sea Research II Dugdale, R.C., F.P. Wilkerson, A.Marchi and V.Hogue. 2006. Nutrient controls on new production in the in the Bodega Bay, California, coastal upwelling plume. In press Deep-Sea Research II. Wilkerson, F.P. R.C. Dugdale, V. Hogue, A. Marchi. 2006. Phytoplankton blooms and nitrogen productivity in San Francisco Bay. Estuaries and Coasts 29: 401-416 Takabayashi, M., K. Lew, A. Johnson, A. Marchi, R. Dugdale, F.P. Wilkerson. 2006. The effect of nutrient availability and temperature on chain length of the diatom, Skeletonema costatum. Journal of Plankton Research 28: 831-840 Hogue, V., F.P. Wilkerson and R,C. Dugdale. 2005 Effects of ultraviolet-B radiation on natural phytoplankton assemblages in central San Francisco Bay. Estuaries. 28: 190-204. Takabayashi, M., F.P. Wilkerson, D. Robertson,. 2005. Response of glutamine synthetase gene transcription and enzyme activity to external nitrogen sources in the diatom, Skeletonema costatum (Bacillariophyceae). J. Phycology 41: 84-94 Ambrust E. V. et al. (incl Wilkerson), 2004. The genome of the diatom Thalassiosira pseudonana: ecology, evolution, and, metabolism. Science, Vol. 306, 79-86. Dugdale, R.C. A.G. Wischmeyer, F.P. Wilkerson, F. Chai, R.T. Barber, T-H. Peng and M. Lyle. 2003 Submitted to PaleoOceanography.. The influence of equatorial diatom processes on Si deposition and atmospheric CO2 cycles at glacial/interglacial time scales Wilkerson, F.P., R. C Dugdale, A. Marchi and C.A. Collins. 2002. Hydrography, nutrients and chlorophyll measured during El Niño and La Niña compared to normal years in the Gulf of the Farallones, CA. Progress in Oceanography 53: 293-310. Chai, F., R. C. Dugdale, T-H Peng, F. P. Wilkerson, and R. T. Barber, One dimensional ecosystem model of the equatorial Pacific upwelling system. Part I: Model development and silicon and nitrogen cycle. Deep-Sea Research II. 49: 2713-2747. Dugdale, R.C., R. T. Barber, F. Chai, T.H. Peng, and F.P. Wilkerson, One dimensional ecosystem model of the equatorial Pacific upwelling system, Part II: Sensitivity analysis and comparison with JGOFS EqPac Data Deep-Sea Research II. 49: 2747-2769. Dugdale, R. C. A. G. Wischmeyer, F.P. Wilkerson, R.T. Barber, F. Chai, M. Jiang and T-H. Peng. 2002. Meridional asymmetry of source nutrients to the equatorial Pacific upwelling ecosystem and it's potential impact on ocean-atmosphere CO2 flux; a data and modeling approach. Deep-Sea Research II. 49: 2513-2533. Hogue, V., F. Wilkerson, R. Dugale and A. Marchi. 2001 Phytoplankton and nutrient dynamics in Suisun, San Pablo and Central Bays. October 2001 IEP Newsletter 14: 35-41.

SYNERGISTIC ACTIVITIES Panel Member, NOAA ECOHAB Joint Genome Institute Diatom (T. pseudonana) Jamboree Annotator Organized AGU Chapman Conference: Role of Diatom Production, Si Flx and Burial in Regulation of Global Cycles, Greece 2003 Institute Editor, Advances in Space Research, Local Outreach Marin County-High School Teachers Workshop Participant High school student and undergraduate mentor (DOE, DOD and MARC supported) Session Organizer and Chair, ASLO Ocean Sciences, Hawaii, San Diego, Santa Fe and San Antonio Journal Reviewer for Limnology &Oceanography, Biological Bulletin, Marine Biology, MEPS,, Coral Reefs, Journal of Exp. Marine Biology and Ecology, JGR, Proposal Reviewer for NSF Biological Oceanography, Chemical Oceanography, JGOFS, Polar Programs, SeaGrant, NOAA

SCIENTIFIC COLLABORATORS IN THE PAST 48 MONTHS (OTHER THAN CO-AUTHORS LISTED ABOVE):

B.B. Ward, J. Zehr, S. Bollens, J. Largier, W. Kimmerer, E.Dever, N. Garfield, D.Nelson, M. Brzezinski, M. Landry, W. Balch, R. Feely, C. Measures.

PH.D. AND POST−DOCTORAL ADVISORS AND ADVISEES: Ph.D. Advisor: Sir David C. Smith, FRS., Post−doctoral Advisors: L. Muscatine, R.K. Trench Graduate Student Advisees: Darci A. Uetrecht, Vickie Hogue, Adria Lassiter, Linda Judah, Amber Johnson, Allison Lorenzi, Laila Barada,

List relevant project/field experience and publications/reports.

Salutation: **Dr**
Last Name: **Carpenter**
First Name: **Edward**
Title: **Professor**
Organization: **Romberg Tiburon Center, San Francisco State University**
Position:
secondary staff
Responsibilities: **Solely responsible for Task 4, microscopy−identfication and enumeration of phytoplankton**
Qualifications:

EDWARD J. CARPENTER Romberg Tiburon Center San Francisco State University TEL:(415)435−7141 FAX:(415)435−7120 email: ecarpent@sfsu.edu

EDUCATION: B.S. State University of New York, College at Fredonia, 1964 M.S. North Carolina State University, 1966 Ph.D. North Carolina State University, 1969

BIOGRAPHICAL SKETCH: Woods Hole Oceanographic Institution, 1969 1975 (Postdoc &Asst. Scientist) Marine Sciences Research Center, Assistant, Associate &Full Professor, SUNY at Stony Brook, 1975 2000 Associate Program Manager, Office of Polar Biology and Medicine, National Science Foundation, 1995−1997. Sabbatical, Botanical Institute, Stockholm University, Sweden, 1991 &1997 Romberg Tiburon Center, San Francisco State University, Professor, 2000−present PhD honoris causa Stockholm University, Sweden 2001 Editorial Board, Journal of Phycology 2004−2007 Fellow, California Academy of Sciences 2004 Advisors: PhD: J.E Hobbie, presently at Ecosystems Center, MBL, Woods Hole Postdoctoral: R.R.L. Guillard, presently at Bigelow Lab for Ocean Science

Research Interests: Phytoplankton ecology, nutrient cycling in marine waters, photosynthesis, nitrogen fixation by marine cyanobacteria &bacteria, phytoplankton nuisance blooms, cyanobacterial symbioses, bacterial ecology. Biology of snow microbes. Carpenter has extensive experience on research ships and has logged over 50 research cruises. He has been Principal Investigator on over 50 Federal government (NSF, NASA) grants. Courses have been taught in Biological Oceanography, Microbial Ecology, Phytoplankton Ecology, Phycology, Marine Biology and Introductory Oceanography.

Collaborators in last 48 months: Bergman, Birgitta, U. Stockholm, Campbell, Lisa, Texas A &M, Capone, Douglas, USC, Falkowski, Paul, Rutgers U. Hood, Raleigh, U. Maryland, Michaels, Tony, USC, Montoya, Joe, Georgia Tech, Sanudo−Wilhelmy, Sergio, Stony Brook U. Villareal, Tracy, U. Texas, Karl, Dave, U. Hawaii, Zehr, Jon, UCSC, Ron Siefert, U Maryland, Craig Cary, U. Delaware

Graduate Students and Postdoctoral Investigators in last 5 years: Lin, Senjie, U. Connecticut, Adam Kustka, Princeton Univ., M. Mulholland, Old Dominion Univ, Ajit Subramaniam, LDEO, Columbia Univ., Jeng Chang, Taiwan Ocean Sciences U. Pirzada Siddiqui, U of Karachi, Luisa Falcon, Atonom. U. Mexico, Rachel Foster, UC Santa Cruz.

Five Recent papers (author of ca. 140 reviewed papers and editor of 5 books) Sanudo−Wilhelmy, S.A., A. Kustka, D.G. Capone, D. Hutchins, C. Gobler, M. Yang, &E.J. Carpenter. 2001. Phosphorus limitation of N2 fixation in the central Atlantic Ocean. Nature, 411:66−69.

Carpenter, E.J., S. Lin, and D.G. Capone. 2000. Bacterial activity in South Pole snow. Applied &Environmental Microbiology. 66:4514−4517.

Lin, S., C.J. Gobler, and E.J. Carpenter. 2001. Cytological and biochemical responses of Dunaliella tertiolecta (Volvocales, Chlorophyta) to iron stress. Phycologia. 40:403−410.

Sañudo−Wilhelmy, S., A. Tovar−Sanchez, F. Fu, D.G. Capone, E.J. Carpenter, &D.A. Hutchins. 2004. The impact of surface adsorbed phosphorus on phytoplankton Redfield stoichiometry. Nature 432: 897−901.

Falcon, L., E.J. Carpenter, F. Cipriano, B. Bergman &D.G. Capone. 2004. Bacterioplankton from the Atlantic and Pacific Oceans: Phylogeny and in situ rates. Appl. Envir. Microbiol 70:765–770.

Five additional papers. Hood, R. A. Subramaniam, L. May, E.J. Carpenter and D.G. Capone. 2002. Remote estimation of nitrogen fixation by Trichodesmium. Deep–Sea Res. II 49/1–3:123–147.

Mulholland, M., S. Floge, E.J. Carpenter and D.G. Capone. 2002. Phosphorus dynamics in cultures and natural populations of Trichodesmium spp. Marine Ecology Progress Series. 239:45–55.

Falcon, L., S. Pluvinage &E.J. Carpenter. 2005. Growth kinetics of marine unicellular N2 fixing cyanobacterial isolates in continuous culture in relation to phosphorus and temperature. Mar. Ecol. Prog. Ser. 285: 3–9.

Villareal, T. and E.J. Carpenter 2003. Buoyancy regulation and potential for vertical migration in the oceanic cyanobacterium Trichodesmium. Microbial Ecology 45:1–10.

Carpenter, E.J., A. Subramaniam &D.G. Capone. 2004. Biomass and primary productivity of the cyanobacterium Trichodesmium spp. in the tropical N Atlantic Ocean. Deep–Sea–Res. I 51:173–203.

List relevant project/field experience and publications/reports.

Salutation: **Dr**
Last Name: **Parker**
First Name: **Alexander**
Title: **Research Fellow**
Organization: **Romberg Tiburon Center, San Francisco State University**
Position:
primary staff
Responsibilities: **Contributes to data analysis for Task 1. Organizes the field program and mesocosms in Tasks 2 and 3. Primary lab responsibility is to run the mass spectrometer for 15N/13C uptake rate measurements. Give scientific presentations and prepare manuscripts. Mentor graduate student**
Qualifications:

ALEXANDER E. PARKER

ADDRESS: Romberg Tiburon Center (415) 338 – 3746 (Phone) San Francisco State University (415) 435 – 7120 (Fax) 3152 Paradise Drive aeparker@sfsu.edu Tiburon, CA 94920 USA

EDUCATION:

University of Delaware, Lewes Oceanography Ph.D., 2004 University of Colorado at Boulder Biology, Geography (Minor) B.A., 1995

RESEARCH EXPERIENCE:

Romberg Tiburon Center for Environmental Studies 2004 – present University of Delaware Graduate College of Marine Studies 1998 – 2004 St Jones Research Reserve, National Estuarine Research Reserve 1999 – 2004 NOAA Office of Coast Survey, Silver Spring, MD 1997 – 1998

RELEVANT FIELD EXPERIENCE:

R/V Hugh R. Sharp research cruise participant, Delaware Estuary and coastal waters, 2006 R/V Roger Revelle research cruise participant, equatorial Pacific 2005 R/V Polaris research cruise participant, San Francisco Bay 2005 R/V David Star Jordan NOAA, research cruise participant, northern California coast, 2005 R/V Questuary, Chief Scientist, 14 1–day cruises, San Francisco Bay 2005–2006 R/V Roger Revelle, cruise participant, equatorial Pacific 2004 USCGC Healy, cruise participant, western Arctic Ocean, 2004 R/V Cape Henlopen, cruise participant, 21 cruises Delaware Bay and coastal waters 2001–2004 NOAA National Estuarine Research Reserve extensive small boat sampling, St Jones estuary, 2002–2003

FELLOWSHIPS AND AWARDS:

University of Delaware College of Marine Studies Publication Award 2005 Delaware Mobile Surf Fishermen Association Graduate Fellowship 2003 NOAA National Estuarine Research Reserve Graduate Research

Fellowship 2000 – 2003 NSF Graduate Research Traineeship Fellowship 1999– 2000 Howard Hughes Biomedical Research Award for Undergraduates 1993 – 1994

PUBLICATIONS:

Published or in review:

Sharp,J.H., Yoshiyama, K., Parker, A.E., Schwartz, M. C., Curless, S. E., Beauregard, A.Y., Ossolinski, J., Davis, A.R. "The chemistry of the Delaware Estuary: seasonal and spatial trends and correlations" Estuaries and Coasts, submitted

Parker, A.E., Fuller,. J., Dugdale, R.C. "Estimating dissolved inorganic carbon concentrations from salinity in San Francisco bay for use in 14C – primary production studies. " Interagency Ecological Program, submitted

Cottrell, M.T., Malmstrom, R.R., Hill, V., Parker, A.E., Kirchman, D.L. "The metabolic balance between autotrophy and heterotrophy in the western Arctic Ocean" Deep Sea Research I, accepted 8/06.

Parker, A. E. (2005). "Differential supply of autochthonous organic carbon and nitrogen to the microbial loop of the Delaware Estuary." Estuaries 28(6): 856–867.

Sharp, J. H., A. Y. Beauregard, Burdige, D., Cauwet, G., Curless, S. E.,Lauck, R., Nagel, K., Ogawa, H., Parker, A. E., Primm, O. (2004). "A direct instrument comparison for measurement of total dissolved nitrogen in seawater." Marine Chemistry 84(3–4): 181–193.

In prep: Parker, A.E., Yoshiyama, K., Hogue, V.E., Sharp, J.H. "primary production estimates by the stable isotope 13c tracer technique: experimental considerations for work in estuaries" in prep Parker, A.E. "The Contribution of NH4+, NO3–, and phytoplankton–released dissolved organic nitrogen to bacterial nitrogen requirements in the Delaware Estuary" in prep.

Parker, A.E., Hogue, V.E., Carpenter, E.J., Marchi, A., Wilkerson, F., Dugdale, R.C."Phytoplankton carbon and nitrogen assimilation during the spring period in San Francisco Bay, USA" in prep.

PUBLISHED ABSTRACTS AND PRESENTATIONS:

Parker, A.E., Hogue, V.E., Wilkerson, F., Dugdale, R.C., 2006 "Foodweb support for the threatened delta smelt –evaluating the potential contribution of bacterial carbon for higher trophic levels" CALFED Science Conference, Sacramento, CA Scott, C., Parker, A.E., Slaughter, A.M. 2006 "Weekly estimates of planktonic respiration rates for central San Francisco Bay and implications for autotrophic–heterotrophic balance " CALFED Science Conference, Sacramento, CA Hogue, V.E. Parker, A.E., Dugdale, R.C., Marchi, A., Wilkerson, F. 2006 "" CALFED Science Conference, Sacramento, CA Parker, A.E., March., A., Hogue, V.E., Lew, K., Lorenzi, A.H., Greeley, D., Feely, R., Wilkerson, F., Dugdale, R.C., 2006 "Nutrient Utilization and Phytoplankton Community Response During Enclosure Experiments Conducted in the Eastern Equatorial Pacific: Testing Fe vs. Si Limitation "American Society of Limnology and Oceanography Ocean Science Meeting, Honolulu, HI Cottrell, M.T., Malmstrom, R.R., Hill, V., Parker, A.E., Kirchman, D.L.2006 "The metabolic balance between autotrophy and heterotrophy in the western Arctic Ocean". American Society of Limnology and Oceanography Ocean Science Meeting, Honolulu, HI Parker, A.E., Hogue, V.E. Wilkerson, F., Dugdale, R.C.2005 "Anthropogenic ammonium as a control on estuarine primary production "Estuarine Research Federation Meeting Norfolk, VA Kleckner, A, Parker, A.E. Lew, K., Hogue, V.E., Wilkerson, F., 2005 "Temporal and spatial variability of chlorophyll a versus particulate carbon and nitrogen relationships in San Francisco Bay: importance for estimating biomass and ecosystem modeling ". Biennial State of the Estuary Conference, Oakland, CA Parker, A.E., Hogue, V.E. Wilkerson, F., Dugdale, R.C. 2005 "Investigating the influence of anthropogenic ammonium on estuarine primary production " California Estuarine Society Meeting, Santa Barbara, CA Parker, A.E., Curless, S.E., Yoshiyama, K., Sharp, J.H. 2004 "Ammonium suppression of primary production in the Delaware Estuary: evidence from mesocosm experiments." American Society of Limnology and Oceanography Ocean Science Meeting, Honolulu, HI Curless, S.E., Parker, A.E., Yoshiyama, K., Sharp, J.H. 2003 "Accurate and precise analysis of primary biological elemental pools to support estuarine mesocosm experiments" American Society of limnology and Oceanography Ocean Science Meeting, Honolulu, HI Parker, A.E. 2003. "Direct measurement of carbon and nitrogen cycling within the estuarine microbial loop". American Society of Limnology and Oceanography Aquatic Science Meeting, Salt Lake City, UT Parker, A.E. 2003 "C–13 and N–15 isotope tagging experiments to assess the importance of the microbial loop in estuarine systems". Estuarine Research Federation Meeting, Seattle WA. Parker, A.E 2003. "The Microbial loop within a salt marsh estuary: The St. Jones River, DE ".NOAA National Estuarine Research Reserve Research Coordinators meeting, Lewes, DE Parker, A.E. 2003 "Carbon and nitrogen cycling within the

microbial loop" Graduate College of Marine Studies, Graduate Student Symposium, Lewes, DE Sharp, J.H.. Beauregard, A.Y., Parker, A.E., Curless, S.E. 2002 "A high temperature combustion instrument comparison for measurement of dissolved organic nitrogen in seawater." American Society of limnology and Oceanography, Ocean Science Meeting, Honolulu, HI Parker, A .E., and Sharp, J.H.2001. "Differential Carbon and Nitrogen Transfer in the Estuarine Microbial Loop: The Role of Nitrogen Concentration and Quality". ASLO/AGU Ocean Science Meeting, Albuquerque, NM Sharp, J.H. Beauregard, A.Y. and Parker, A.E. 2001 "Recent changes in nutrient ratios in estuaries and coastal waters: What is the impact?" Estuarine Research Federation Conference, Miami, Fl Schwartz, M., Parker, A.E., Beauregard, A.Y., Sharp, J. H. 2000 "Temporal and Spatial Variations in Microbial Biogeochemistry of a coastal plain estuary". ASLO Aquatic Science Meeting. Copenhagen, Denmark Parker, A.E., Beauregard, A.Y., Chandler, E , Schwartz, M,, Sharp, J.H. 2000 "Evaluating microbial loop using dual isotope tagging" AGU/ASLO Ocean Science Meeting, San Antonio, TX. Beauregard, A.Y., Parker, A.E., Schwartz, M, Sharp, J.H. 2000 "Evaluating estuarine health through nutrient and gas stoichiometry" .AGU/ASLO Ocean Science Meeting, San Antonio, TX Parker, A.E. and Lockwood, M. 1998 "Classification of Shoreline Data for GIS Applications". Coastal Society Meeting. Williamsburg, VA.

PROFESSIONAL MEMBERSHIPS:

American Society of Limnology and Oceanography Estuarine Research Federation California Estuarine Research Society

PROFESSIONAL SERVICE AND OUTREACH:

Reviewer for Coastal, Estuarine and Shelf Science Journal Reviewer for Journal of Plankton Research Judge – Student presentations – Estuarine Research Federation Biennial Conference 2005 Reviewer for CALFED Science Advisory Board Student Representative, Graduate College of Marine Studies Academic Council 2000 – 2004

Marin County, CA, Science Fair Judge, 2006 Sussex County, DE, High School Science Fair Judge 2000, 2001 Smyrna High School, Delaware – Ocean Science Bowl Coach, 2001 National Ocean Science Bowl, Baltimore, MD – Judge 2000 Governor's School for Excellence, Wilmington, DE Summer High School Program workshop leader 1999–2000 Milton Middle School – Instructor "Ecology of Salt Marsh Estuaries" 1998, 2003 Partnership for the Delaware Estuary – Invited Lecture "Historic Changes in Water quality in the Delaware Estuary", 2002 University of Delaware's Coast Day Celebration, Organizer and facilitator for laboratory demonstration (for J. H. Sharp)

List relevant project/field experience and publications/reports.

Salutation: **Mr**
Last Name: **Marchi**
First Name: **Albert**
Title: **Senior Research Technician**
Organization: **Romberg Tiburon Center, San Francisco State University**
Position:
primary staff
Responsibilities: **Help analyze data and prepare deliverables for Task 1. Participate in cruises and mesocosm experiments. Small boat driver. Primary lab responsibility is nutrient analyses for samples collected in tasks 2 and 3.**
Qualifications:

AL M. MARCHI Romberg Tiburon Center for Environmental Studies San Francisco State University 3152 Paradise Drive, Tiburon, CA 94920 415.338.3544, Email: amarchi@sfsu.edu

Education:

M.A. (Marine Biology and Limnology) 1998 San Francisco State University, B.A. 1986 University of Miami, Coral Gables Florida, 33134

Publications:

Marchi, A. and Carrick, H.J. 2006. Variation in water quality and phytoplankton nutritional status in an urbanized lake system (Lake Merced, California, USA). Journal of Lake and Reservoir Management 22(1): 33–43. Takabayashi, M., Lew, K., Johnson, A., Marchi, A. Dugdale, R., Wilkerson, F.P. 2006. The

effect of nutrient availability and temperature on chain length of the diatom, Skeletonema costatum. Journal of Plankton Research. 28: 831–840. Hogue V. E., Wilkerson F. P., Dugdale R. C., and Marchi A. 2001. Phytoplankton and nutrient dynamics in Suisun, San Pablo, and Central San Francisco Bays. Interagency Ecological Program for the San Francisco Estuary 14(4): 35–41. Wilkerson, F., Dugdale, R.C., Marchi, A.M., Collins, C.A. 2001. Hydrography, Nutrients and Chlorophyll During El Nino and La Nina 1997–99 Winter's in the Gulf of the Farallones, CA. Progress in Oceanography (El Nino Special Volume): June 2001. McGowan, M. and A.M. Marchi. 1998. Fishes Collected in Submersed Aquatic Vegetation, Egeria densa, in the Delta. Interagency Ecological Program for the San Francisco Estuary 11(1): 9–10. Marchi, A.M. 1998. The Effects of Nutrient Limitation on an Urbanized Lake System: Lake Merced, CA. San Francisco State University, Master's Thesis.

Work Experience:

OCEANOGRAPHIC TECHNICIAN, SFSU–ROMBERG TIBURON CENTER (OCT. 1997 – PRESENT) • Manage biological oceanography research laboratory. • Coordinate, organize, and conduct monthly research cruises on San Francisco Bay, month–long cruises to Gulf of the Farallones, weekly Monterey Bay crises, Equatorial Pacific (month long cruises) • Facilitate the collaboration of research efforts with a variety of local and national marine laboratories: National Marine Fisheries Service (NMFS) Santa Cruz Laboratory, Bodega Marine Laboratory, Scripps Institute of Oceanography, and Rutgers Marine Laboratory. • Maintain ongoing oceanographic monitoring station on central San Francisco Bay which includes a CTD, Flow Cytometer, and automated nutrient analyzer (ECOLab). • Oversee the collection of physical (CTD), chemical (nutrients) and biological (phytoplankton) data on cruises. • Oversee all wet chemistry analyses using an Autoanalyzer. • Conduct data analysis and management of all active laboratory projects using MS Excel, Systat, Grapher, and Surfer. • Help write and provide data and background information for research grant proposals. • Create posters and graphics for academic conferences and public outreach projects. • Give presentations for visiting professors, student groups, and the general public regarding the laboratories ongoing research, and the general ecology of San Francisco Bay. • Supervise and instruct graduate and undergraduate students in aquatic ecology methods and data analysis techniques. • Small–boat handling– Coast Guard certified.

FISHERIES BIOLOGIST, NATIONAL MARINE FISHERIES SERVICE, CA (FEB. 1997 – OCT. 1997)

• Carried out anadromous fish research on Coho salmon and California steelhead in Marin, Sonoma, and Mendocino counties. Project scope was to complete a 2 year presence/absence survey for a NMFS technical report and to perform a basin–wide estimate survey for Coho salmon on the Ten Mile River (Mendocino County) in conjunction with Georgia–Pacific West, Inc. fishery biologists and the California Department of Fish and Game (CDFG). • Conducted snorkel surveys, electrofishing, and stream habitat typing in 30 streams and rivers. • Researched and created databases in MS Excel with current California salmonid abundance estimates from their central and northern ESU's. • Researched salmonid life histories and salmonid biology pertaining to the project.

Field Biologist, Garcia and Associates (GANDA), San Anselmo, CA (June 1996)

• Collected baseline data for CEQA documentation on the migration patterns of Chinook salmon smolts through the San Joaquin River for the East Bay Municipal Utility District. • Aided senior fisheries biologist in testing a new method of tracking the migration patterns of Chinook salmon smolts from the Sacramento/San Joaquin Delta river system to San Francisco Bay using radio telemetry techniques. • Tracked salmon smolts for 12 hour periods using a motorized boat and acoustical gear. • Assisted in the data processing, analysis, and final report for the project.

List relevant project/field experience and publications/reports.

Salutation: **Miss**
Last Name: **Hogue**
First Name: **Victoria**
Title: **Senior Research Technician**
Organization: **Romberg Tiburon Center, San Francisco State University**
Position:
primary staff
Responsibilities: **Help manage data, maintain web page and prepare deliverables for Task 1. Participate in cruises and mesocosm experiments. Primary lab responsibility is to measure chlorophyll and prepare mass spectrometry sub–samples from water collected in tasks 2 and 3.**
Qualifications:

VICTORIA E. HOGUE RTC 3152 Paradise Dr. Tiburon, CA 94920

Education: M.A. Marine Biology, San Francisco State University. December 2000. Thesis: "The Effects of Ultraviolet-B Radiation on Natural Phytoplankton Assemblages in Central San Francisco Bay"

B.S. Aquatic Biology, University of California at Santa Barbara. December 1994. Undergraduate independent projects: "Natural Reefs vs. man-made Reefs: Population Dynamics of Four Species of Fish in Baja California, Mexico" and "The Effects of Forest Fires on Stream Benthic Invertebrates"

Publications:

Wilkerson F. P., Dugdale R. C., Hogue V. E., Marchi, A., 2006. Phytoplankton blooms and nitrogen productivity in San Francisco Bay. Estuaries and Coasts, Vol. 29, no. 3, 401-416. Hogue V. E., Wilkerson F. P., Dugdale R. C. (2005). Ultraviolet-B Radiation Effects on Natural Phytoplankton Assemblages of Central San Francisco Bay. 2005. Estuaries 28(2):190-203 Strutton, P. G; Chavez, F. P; Dugdale, R. C; Hogue, V. (2004). Primary productivity in the central equatorial Pacific (3 degree S 130 degree W) during GasEx-2001. Journal of Geophysical Research. C. Oceans [J. Geophys. Res. (C Oceans)]. Vol. 109, no. C8, [np]. Jul 2004. Hogue V. E. (2000). Ultraviolet-B radiation effects on natural phytoplankton assemblages of Central SanFrancisco Bay. San Francisco State University. MA thesis:1-104 Hogue V. E., Wilkerson F. P., Dugdale R. C., and Marchi A.(2001). Phytoplankton and nutrient dynamics in Suisun, San Pablo, and Central Bays. Interagency Ecological Program for the San Francisco Estuary 14(4): 35-41.

Employment History: Research Technician I Romberg Tiburon Center, CA (1/98-present)

• Cultured, grew, and maintained several species of phytoplankton using sterile techniques. Monitored cultures for bacterial contamination via epifluorescence and for growth via chlorophyll a extraction and cell counts using a hemocytometer • Served as Chief Science Officer on monthly cruises for an interdisciplinary, multi-investigator, EPA (Environmental Protection Agency) funded grant to assess indicators of stress in organisms of different trophic levels. Also served as a lead research technician on other research cruises including the NSF (National Science Foundation) funded CoOP-WEST project in Northern California. Duties on these cruises included: planning the cruise route with the ship Captain or Chief Science Officer where appropriate; designing and carrying out on-board experiments and sample collection; supervising and coordinating other technicians and graduate students within my research group; acting as the primary contact to coordinate research interactions with other groups on or off the ship; maintaining on-board data logs and providing analysis and preparation of data upon return • Organized and supervised the sample processing for all cruises using such techniques as: chlorophyll-a extraction utilizing a flourometer, ammonium analysis by a spectrophotometer, nitrate, silicate, and phosphorus analysis via an auto analyzer, and gas chromatography using mass spectrometry • Compiled, organized, and assisted in analysis of acquired data from all cruises for grant reporting, collaborative scientific journal publications, and for presentation at scientific meetings and conferences • Supervised and coordinated activities of all graduate student, undergraduate student, intern, and volunteer personnel • Created a financial system for monitoring expenditures and tracking the grant budget • Designed the web site and served as webmaster for the Dugdale/Wilkerson Laboratory web site (http:\\userwww.sfsu.edu/~phytopl) which includes regular updating and maintenance of all pages and information

Graduate Teaching Assistant San Francisco, CA (1-6/97 and 1-6/98)

Assisted the professor with teaching responsibilities for Biology 502, Biology of the Algae, in the Spring semesters 1997 and 1998. • Responsible for the laboratory component of the course which included practical field work as well as in-lab analysis • Duties also included assembling laboratory materials, collecting various species for in-lab identification, and providing guidance/support to students in class so that they could complete thir required independent projects

Senior Bioprocessing Technician Genentech, Inc., CA (3/96-3/99)

• Responsible for the protein harvest and purification which involved diafiltration and various forms of liquid column chromatography and tangential flow filtration • Prepared the chemical buffers used during the harvest and purification processes following established protocols and GMP specifications • Served as Skid Owner and managed the operation, testing, and troubleshooting of the equipment prior to use; reviewed documents (tickets, S.O.P.'s, etc.) for accuracy; trained junior technicians on the equipment usage and operation • Served as weekend Lead Technician supervising up to 10 staff members; coordinated the staff and prioritized the work load to efficiently expedite the purification process; prepared staff performance evaluations; served as the interdepartmental liaison and primary contact for

department communications • Data Entry Clerk Palmer Research Station, Antarctica (3/95–9/95) Research Assistant Palmer Research Station, Antarctica (3/94–9/94) • Entered and analyzed the generated experimental data as well as the data related to the growth and maintenance of the phytoplankton • Participated in two research vessel cruises on the R/V Polar Duke and assisted with on–board experiments and species identification

Research Diver and Lab Assistant University of California, Santa Barbara, CA (9/93–3/95) • Assisted in the collection and maintenance of kelp dwelling species for experimental purposes. • Certified research diver for UCSB on university sponsored projects

List relevant project/field experience and publications/reports.

Salutation: **Miss**
Last Name: **Kleckner**
First Name: **Amy**
Title: **Masters Graduate Student**
Organization: **Romberg Tiburon Center, San Francisco State University**
Position:
secondary staff
Responsibilities: **Participates in the field and enclosure studies, Tasks, 2 and 3; carry out all DIC measurements and flow cytometry**
Qualifications:

Has participated as a SFSU undegraduate on two RV Polaris cruises and a NOAA/NMFS Fisheries cruise in 2005/2006. Worked as summer intern (2006) in Jan thompson's la at USGS, Menlo Park Received MSc Bioloy SFSU, 2006

List relevant project/field experience and publications/reports.

Conflict Of Interest

This is proposal #0065 for the Science Program 2006 solicitation.

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

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

Instructions

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

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

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

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

Last Name	First Name	Organization	Role

Task And Budget Summary

This is proposal #0065 for the Science Program 2006 solicitation.

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

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

Instructions

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

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

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

Task #	Task Title	Start Month	End Month	Personnel Involved	Description	Task Budget
1	Project Management	1	36	Dugdale, Richard Wilkerson, Frances Parker, Alexander Marchi, Albert Hogue, Victoria	This represents project oversight, data handling, preparation of reports, and outreach activities.	62,412
2	Suisun Habitat Description	1	36	Dugdale, Richard Wilkerson, Frances Parker, Alexander Marchi, Albert Hogue, Victoria Kleckner, Amy	To assess the anomalous Suisun habitat (“Bad Suisun”) in context of the Delta, upstream (into the Sacramento and San Joaquin Rivers) and downstream (a more typical estuarine condition in Central Bay). Will measure gradients in hydrography, nutrients, chorophyll and focus especially on gradients in physiological pytoplankton rates (i.e. gwoth rtaes nutrient uptake and primary productivity using 15N and 13C).	210,531
3	Experimental Manipulations	1	36	Dugdale, Richard Wilkerson, Frances Parker, Alexander Marchi, Albert Hogue, Victoria Kleckner, Amy	To use experimental mesocosms/enclosures to optimize growth conditions of natural phytoplankton and evaluate [physiological response of the phytoplankton to changing conditions. They will be used to evaluate the relative response to changing conditions (drivers) of Suisun phytoplankton growth with those from upstream freshwater and downstream, oceanic populations. In addition we will “test” water from Suisun Bay as growth medium for other phytoplankton communities–isolated for elsewhere in SFE or phytoplankton mixtures cultured in the lab. at the appropriate salinity.	240,781
4	Phytoplankton Condition Analysis	1	36	Carpenter, Edward	This tasks funds Dr Carpenter to identify and enumerate the phytoplankton community species in Suisin and Central Bays, Delta and the Sacramento	48,032

					and Joaquin Rivers. Also health or condition f the cels will be documented	
5	**Modelling Change**	**1**	**36**	**Dugdale, Richard**	**To develop a simple ecological model to predict the effect of reducing the “bad” condition on phytoplankton physiology and community structure in Suisun bay to determine if management practices aimed at this trophic level are feasible for trying to alleviate the POD.**	**43,995**

total budget=$605,751

Detailed Budget Upload And Justification

This is proposal #0065 for the Science Program 2006 solicitation.

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

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

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

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

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

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

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

Uploading The Completed Budget Template

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

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

Uploading The Completed Budget Justification

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

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

Uploading The Description Of Cost Share/Matching Funds

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

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

Schedule Of Deliverables

This is proposal #0065 for the Science Program 2006 solicitation.

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

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

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

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

Deliverable	Description	Delivered By: # (In Months From Project Start Date)
one page summary at start	CALFED required for public audience at beginning of project	1
one page summary at end	CALFED required for or public audience upon project completion	36
semi−annual report 1	CALFED required every 6 months	6
semi−annual report 2	CALFED required every 6 months	12
semi−annual report 3	CALFED required every 6 months	18
semi−annual report 4	CALFED required every 6 months	24
semi−annual report 5	CALFED required every 6 months	30
fnal report	CALFED required −sumary of results and pubications	36
Project closure summary report	CALFED required − summary of data collected and accounting	36
Presentation at CALFED Science Conferences	Conferences held every 2 years in October 2008	20
Copy of all manuscripts and published material to CALFED	Online and paper manuscripts produced with this funding	36
Presentation at State of Estuary M	Alternates with CALFED Science confereces, Oct 2007	8
Presentation at State of Estuary M	Alternates with CALFED Science confereces, Oct 2009	32
Presentation at IEP Annual Meeting, Asilomar	Annually each March, 2008	13
Presentation at IEP Annual Meeting, Asilomar	Annually each March, 2009	25
Presentation at ERF	Estuarine Research Federation Conference, Oct 2007	8
Presentation at ERF	Estuarine Research Federation Conference, Oct 2009	32
Presentaton at ASLO	American Society of Limnology and	

	Oceanography, March 2008	**15**
Presentation at EET Workshops	**Estuarine Ecology Team of IEP meets quarterly, Aug 2007**	**6**
OutReach teacher Workshop	**February 2008**	**12**

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

Do Low Phytoplankton Growth Rates Signal the "Bad" Habitat Conditions in Suisun Bay Driving the Pelagic Organism Decline?

1. PROJECT PURPOSE

Statement of the Problem

Recent declines in numerous pelagic fishes in the upper San Francisco Estuary (SFE; the Delta and Suisun Bay) and the need to understand the underlying causes resulted in the formation of a Pelagic Organism Decline (POD) project work team by the Interagency Ecological Program (IEP). Initial studies resulted in two narrative explanations: 1) the *Winter Entrainment Hypothesis* and 2) the *Bad Suisun Bay Hypothesis*. This proposal addresses the second hypothesis, which focuses on food web effects in Suisun Bay and the western delta. In their 2006-7 work plan the team identified toxic effects on food items (ie phytoplankton) as a possible stressor on the impacted estuarine fishes and indicated that limited or no information was available. Additionally, plans to enhance food sources in the Upper SFE are currently under consideration as part of a report on actions to address the Pelagic Organism Decline in preparation by the California Resources Agency (see **Letter of Support** from Anke Mueller-Solger). One considered action is to construct shallow inundated floodways on a subsided Delta island in the confluence area of the Sacramento and San Joaquin Rivers. These floodways would be fed from channels containing naturally occurring phytoplankton assemblages and would be designed to provide conditions for increased production of nutritionally valuable phytoplankton species. However, many uncertainties remain regarding the response of phytoplankton species from the Delta and Suisun areas to floodway conditions.

Our previous research in SFE shows that conditions in Suisun Bay are far less favorable for phytoplankton growth and chlorophyll accumulation than in San Pablo and Central Bays. The growth rate or productivity of the phytoplankton results from increased biomass and increased rates of nutrient uptake and carbon fixation. Our data (see **Background**) indicate that the nutrient uptake capacity of the Suisun phytoplankton is below that of Central and San Pablo phytoplankton

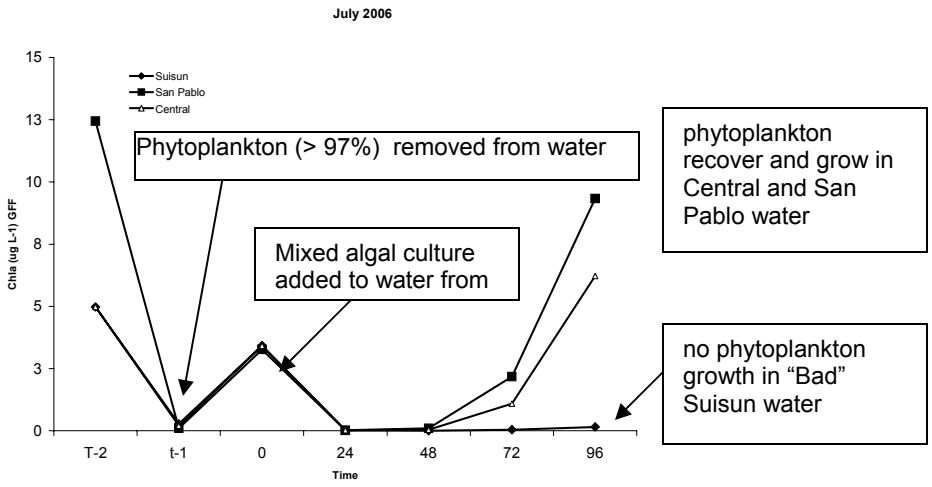


Fig. 1. Enclosure/Mesocosm experiment in which resident phytoplankton were removed from water and then algae (originally isolated from northern SFE) added. There was no chlorophyll increase in Suisun Bay water.

and this results in less biomass. Other known stressors of the system (e.g. *Corbula* effects) will modulate the chlorophyll biomass. We have used experimental enclosures to test how SFE water (without resident phytoplankton) influences the growth of a phytoplankton innoculum and observed that they do not grow in Suisun Bay water whereas they will in Central and San Pablo Bay water (Fig. 1). Enclosures that contained both SFE water and the resident phytoplankton showed delayed or no response by Suisun water to improved light or nutrient conditions, compared to water from San Pablo and Central Bays. These observations lead us to believe that there is something "bad" about the water in Suisun Bay for phytoplankton growth and to ask the following

Scientific Questions

1. Is the "bad" habitat for phytoplankton in Suisun Bay an anomalous condition or part of a continuum between freshwater and oceanic systems?

2. What drivers contribute to the low phytoplankton growth rate in Suisun Bay and how well can the phytoplankton recover when these are removed or changed?

3. If Suisun and Delta phytoplankton are encouraged to grow in near natural conditions, which phytoplankton members of the community respond? What is the underlying physiological mechanism?

4. Can an adaptive management approach be identified to alleviate the diminished food sources linked to the POD?

Hypotheses

1. Suisun is an anomalous ecosystem in the midst of a normal transition. i.e. something is wrong in the locality of Suisun. Phytoplankton condition and growth rates will be greater both upstream and downstream.

2. Physiological drivers specific to Suisun Bay are toxic or inhibitory to phytoplankton nutrient uptake and primary productivity rates. These may be local sources of unknown toxicity to phytoplankton (perhaps agricultural sources of chemicals, NH_4 at high concentrations). These drivers are dissolved within the water column and will inhibit growth of phytoplankton inoculated to the water.

3. Water with native phytoplankton sampled from Suisun Bay and enclosed in experimental mesocosms to stimulate growth will show a less than optimal response compared to water sampled from upstream and downstream.

4. Enclosing water in mesocosms will cause a phytoplankton community change to more resistant species that will likely be fast growing opportunistic diatoms.

5. Reducing the Suisun Bay "bad" driver by dilution will allow Suisun Bay phytoplankton to thrive and improve lower trophic levels feeding the Delta food web .

Scientific Objectives

To test these hypotheses and begin to answer our scientific questions, we have developed a defined series of Scientific Objectives that parallel the Proposed Tasks of this Research Proposal. **Task 1** is a mandatory administrative (to PSP) Project Management task.

1. To assess the anomalous Suisun habitat ("Bad Suisun") in context of the Delta, upstream (into the Sacramento and San Joaquin Rivers) and downstream (a more oceanic condition in Central Bay). Besides measuring gradients of bulk constituents (e.g. phytoplankton abundance as chlorophyll, nutrient concentration) which may not provide a very sensitive index, this task will focus on measuring physiological rates that respond more quickly to changing conditions (e.g. photosynthesis, nutrient acquisition, growth rate). This is the focus of **Task 2 Suisun Habitat Description.**

2. To use experimental mesocosms/enclosures to optimize growth conditions of natural phytoplankton and evaluate physiological response of the phytoplankton to changing conditions. This is **Task 3 Experimental Manipulations,** that closely parallels the field measurements of Task 2. These types of experiments have been used effectively to compare water (and phytoplankton) condition and response in Suisun Bay with those of San Pablo and Central Bays. Here they will be used to evaluate the relative response to changing conditions (drivers) of Suisun phytoplankton growth with those from upstream freshwater and downstream, oceanic populations. In addition we will "test" water from Suisun Bay as growth medium (in a dilution series) for other phytoplankton communities- isolated from elsewhere in SFE or phytoplankton mixtures cultured in the lab. at the appropriate salinity.

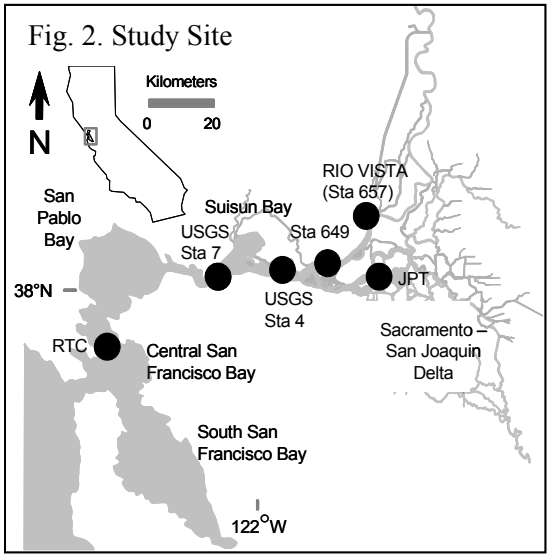
3. To measure phytoplankton community differences by identifying and enumerating phytoplankton species that occur in Suisun Bay, downstream in oceanic Central bay and freshwater upstream locations using light microscopy. Cells will also be examined for cellular condition. This is **Task 4 Phytoplankton Condition Analysis.** This knowledge is required to evaluate food quality for the different food webs.

4. To develop a simple ecological model to predict the effect of reducing the "bad" condition on phytoplankton physiology and community structure in Suisun bay to determine if management practices aimed at this trophic level are feasible for trying to alleviate the POD. This is the heart of **Task 5 Modeling Change.**

Below we describe our previous research in SFE directed as a scientific background to these proposed tasks, with the aim of developing the theme that water in Suisun Bay is somehow bad or detrimental to the physiology of lower trophic levels contributing to the decline in chlorophyll levels and reduced food supply for threatened fish species in the Delta.

2. BACKGROUND AND CONCEPTUAL MODELS

Fig. 2. Study Site



Physical Setting (Fig. 2)

This proposal focuses on Suisun Bay (sampling at USGS stations 4 and 7) but also plans to sample both downstream at a more oceanic site in Central Bay off Romberg Tiburon Center (RTC) and upstream in the Sacramento River (USGS station 649) up to Rio Vista (USGS station 657) and into the San Joaquin river to Jersey Point (JPT).

Conceptual Model: Phytoplankton and the POD

Suisun Bay and the western Delta of the San Francisco Estuary make up an area identified as critical habitat for the threatened Delta Smelt (Hobbs et al., 2006). Several important changes in the pelagic food web of this area have been documented over the last two decades indicating that food for Delta Smelt and other threatened fishes is in short supply (Müller-Solger et al. 2002). Perhaps one of the more striking changes in Delta is the sharp decline in phytoplankton between 1975 -1995 (Jassby et.al., 2002). The conceptual model of the delta pelagic species put forward by the IEP POD Project Work Team includes phytoplankton and has arrows as "reduced food supply" leading to zooplankton and "reduced food supply" leading from zooplankton to pelagic fishes. The model also has an arrow leading from contaminants to phytoplankton producing mortality or reduced fitness. We have observed anomalously low phytoplankton growth and productivity in Suisun Bay in contrast to San Pablo and Central Bays which may contribute to the POD.

Our simple conceptual model for the Suisun habitat (Fig. 3) uses phytoplankton physiology to indicate or signal the "bad" conditions (circles). For contrast, Central Bay (squares) offers an ecosystem without the "bad" components (circles) in which the phytoplankton productivity (i.e. physiology) is primarily limited by light and modulated by NH_4 effects on NO_3. The available NO_3 fuels chlorophyll accumulation that results in spring blooms (high quality phytoplankton biomass). The fresh water habitat

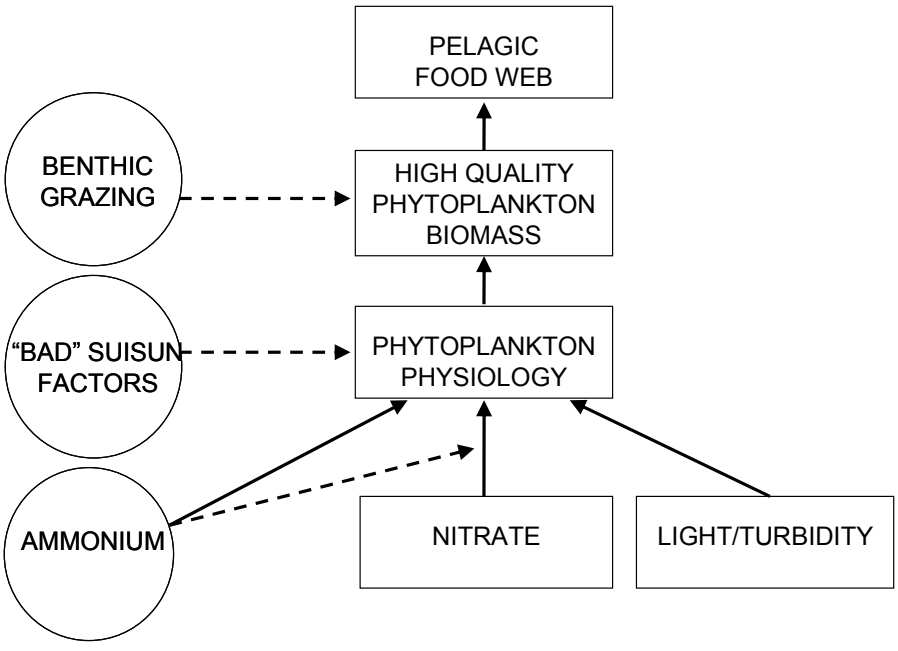


Fig. 3. Conceptual model of "bad" habitat, showing Suisun specific factors in circles that are inhibitory (dotted lines) to growth and chlorophyll accumulation.

upstream of Suisun may also have similar controls on phytoplankton growth (physiology) but this is an unknown. Our working hypothesis is that Suisun is an anomalous estuarine habitat in which low phytoplankton growth rates; i.e. inhibitory effects (dotted lines) on physiology result in little chlorophyll of poor quality and a starved Delta food web. Removal of the "bad" factors (in circles) should switch the physiology (and growth and community structure) towards the high quality phytoplankton food supply that occurs in Central Bay. These "healthy" conditions may also exist further upstream but there are no published phytoplankton growth rates for this region. The proposed research plans to make these measurements.

Primary Productivity in SFE

Prior studies of phytoplankton in SFE attribute a low standing stock of phytoplankton and low rates of primary productivity (Cole and Cloern, 1984; Cloern, 1996) to turbidity (Cloern, 1987, 1991) resulting in light limitation (Alpine and Cloern, 1988). Also implicated is benthic grazing (Nichols and Thompson, 1985, Kimmerer and Orsi, 1996, Lehman 2000) especially by invasive species such as the Asian clam, *Potamocorbula amurensis* (Alpine and Cloern, 1992), now known as *Corbula amurensis* (Coan, 2002). Seasonal phytoplankton blooms have been observed following periods of high freshwater flow, when stratification reduces both the effects of benthic grazing and light limitation (Cloern 1982, 1984, 1991; Cloern et al. 1983; Lucas et al. 1998). Reported primary productivity values for the estuary (e.g. Cloern, 2001) are mostly derived from the commonly used primary productivity model of Cole and Cloern (1984, 1987) recently updated for use in the Delta (Jassby et al. 2002) that empirically derives carbon fixation from values of chlorophyll, incident light and transparency.

More recently (1999-2003), funded by EPA we have measured

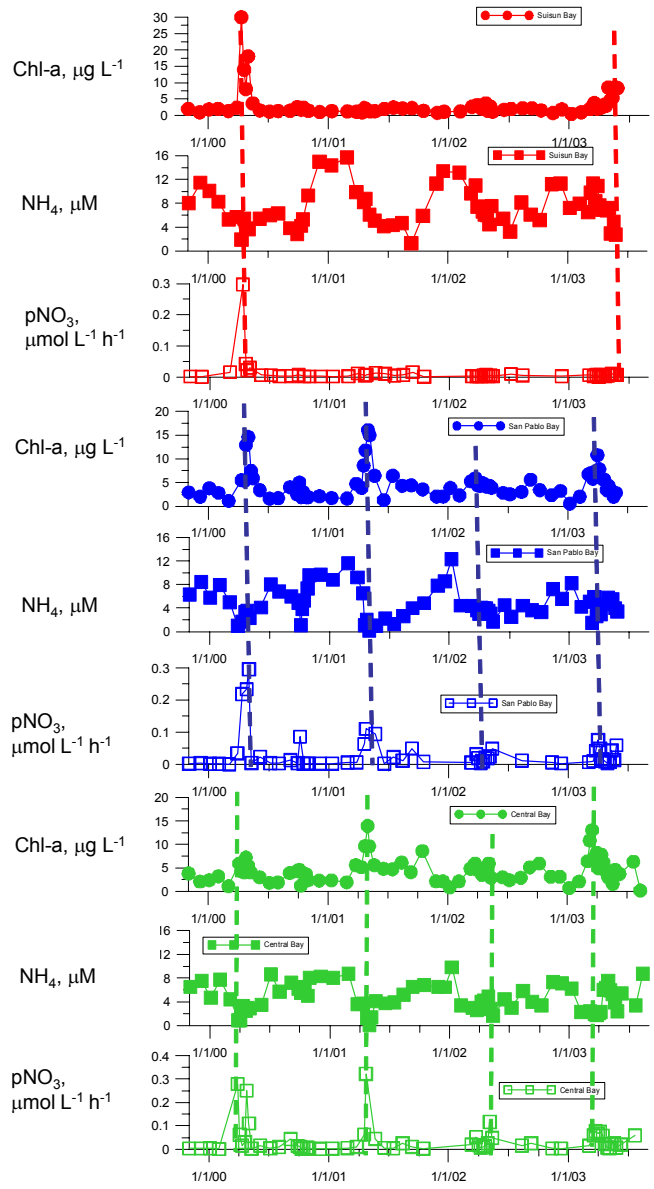


Fig. 4. Time series from Nov. 1999-Aug. 2003 for Suisun (red), San Pablo (blue) and Central Bays (green), dotted lines show timing of annual spring phytoplankton blooms, when chlorophyll is high, NH_4 low and NO_3 uptake high.

nutrients, chlorophyll biomass and nitrogen productivity (as a proxy for primary productivity) in Central, San Pablo and Suisun Bay (Fig. 4). All embayments had high nutrients throughout the year with relatively low mean seasonal chlorophyll concentrations ranging from 1.2 - 6.5 µg l^{-1}. The three bays exhibit a continuum of environmental variables, from fresher waters to the north with higher nutrients to the more oceanic waters of Central Bay. (Wilkerson et al., 2006). However, Suisun Bay exhibits primary production and nutrient uptake processes that are unlike those of San Pablo and Central Bay. Both these related processes are lower in value in Suisun Bay compared to the other 2 bays. The evidence is presented in Wilkerson et al. (2006) and Dugdale et al. (2006). All three bays are primarily light limited due to high turbidity and turbulence but exhibit spring blooms that vary strongly in intensity and time of occurrence.

The form of available dissolved inorganic nitrogen (DIN), nitrate (NO_3) or ammonium (NH_4) makes a difference to the amount of primary productivity and chlorophyll accumulation that can occur. The relative concentrations of NH_4 and NO_3 act together as a secondary control (limitation) on primary production after irradiance. High ambient NH_4 concentrations in all three bays inhibit NO_3 uptake most of the year, i.e. most of the year phytoplankton in all three bays use NH_4 as their primary inorganic nitrogen source. Increased primary production and chlorophyll biomass accumulation only occurs in the northern SFE with utilization of NO_3 (Fig. 5 left panel, large bubbles . Whereas in the two southern bays, increasing NH_4 concentrations were related to increasing NH_4 uptake rates, in Suisun the NH_4 uptake rates were flat, relatively low and unchanging (Fig. 5 right panel).

Wilkerson et al (2006) described how phytoplankton growth during most of the year is supported by NH_4 at relatively low growth rates (e.g. 0.013 h^{-1} in Central Bay in summer). These rates are likely held low by insufficient irradiance. Phytoplankton growth on NO_3 yields higher rates than NH_4 and greater chlorophyll accumulation, since biomass increase is set by the much higher pool of NO_3, 20-30 µM However much of the year this cannot occur as NH_4 is at levels inhibitory to NO_3 uptake by phytoplankton (e.g. Dortch, 1990) so this source of DIN is unavailable for growth.

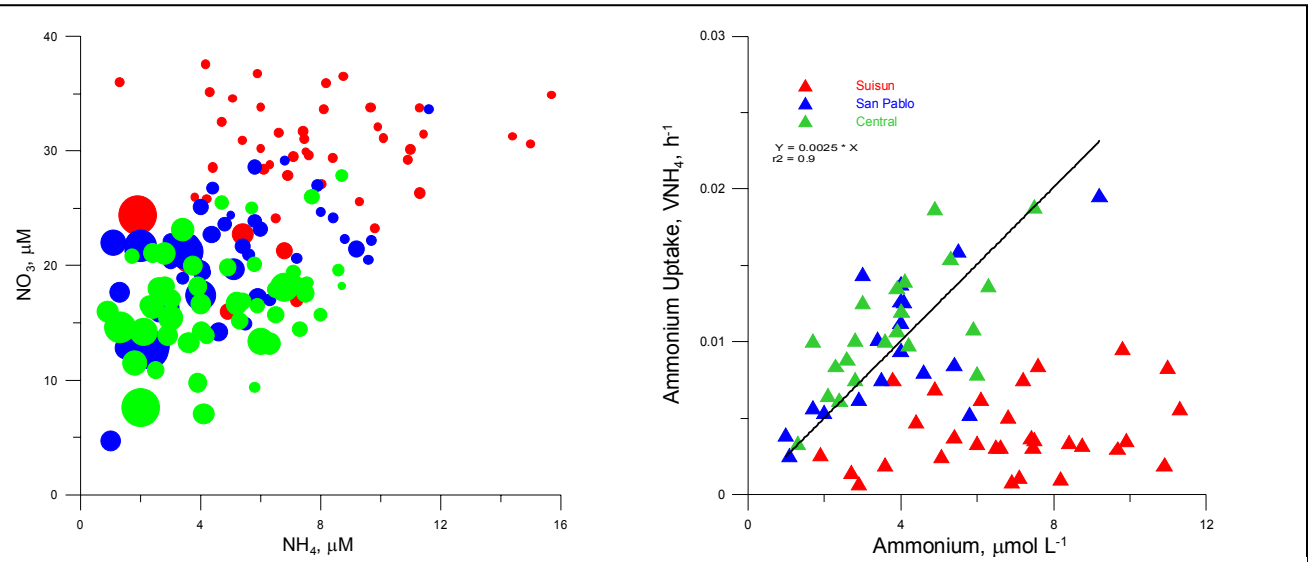


Fig. 5. Left panel shows NO_3versus NH_4, for Suisun (red), San Pablo(blue) and Central (green)Bays with bubbles that indicate chlorophyll concentration. More chlorophyll results with low NH_4 and high NO_3. Right panel showsNH_4 uptake versus NH_4 concentration; Suisun values (red) are all low showing reduced ability to grow on NH_4.

Blooms can occur when vertical salinity stratification improves the light conditions (e.g. in spring) and in the presence of low, non-inhibitory concentrations of NH_4. The responding burst in phytoplankton (typically diatom) growth based on nitrate outpaces grazing and chlorophyll accumulates. This was only observed once in Suisun Bay in Spring 2000, a wet season when NH_4 (and maybe other dissolved water constituents) was diluted by precipitation and nitrate was made available for phytoplankton growth.

Phytoplankton Response in Experimental Mesocosms

As briefly mentioned above, the anomalous conditions in Suisun were most effectively revealed from a series of mesocosms. We showed previously through enclosure experiments that a consistent temporal pattern occurs when water is isolated from advective forces and given irradiance conditions equivalent to 15% or more of surface irradiance: First NH_4 is reduced to low values by phytoplankton uptake, usually within two days then NO_3 uptake rates increase to higher values than were present for NH_4 uptake, and within 5 days all NO_3 is depleted (Fig. 6). The time required before NO_3 uptake begins is lengthened as the initial NH_4 concentration increases. High chlorophyll concentrations at a ratio of about 1 $\mu g\ l^{-1}$ chl are produced for each 1 μM NO_3 taken up. We have now made 20 such enclosure experiments with the same pattern in every case. Central and San Pablo Bays show results consistent with each other and with earlier Central Bay experiments (Hogue, 2000). However, Suisun Bay was different, showing low initial NH_4 uptake rates (consistent with previous field data), increasing slowly with time to ""normal" values, but with the result that NO_3 uptake and chlorophyll production was delayed to begin about 5 days or more after enclosure. (Fig. 6).

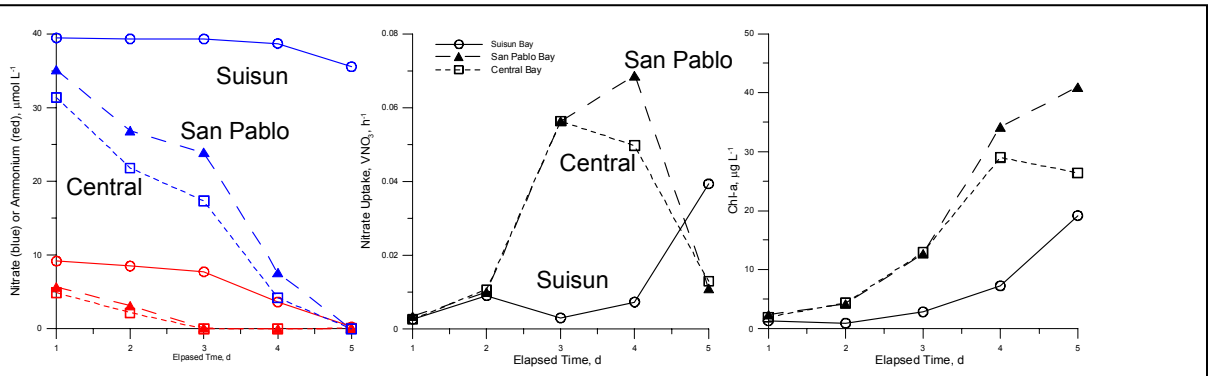


Fig. 6. Enclosure experiments with water from 3 embayments during March 2005 show similar trend to Fig 4, NO_3 drawdown (blue) starts once NH_4 is < 4 µM (red), and then VNO_3 increases (central panel) and chl-a accumulates (right panel). Lag effect in Suisun enclosures.

The Role of *Corbula*

In Suisun Bay, the historic decline in phytoplankton abundance (i.e. chlorophyll) that likely contributes to the POD has been described as a result of the grazing by an introduced clam, *Corbula amurensis* (e.g. Cloern and Alpine, 1991). However, the clam population is at a minimum in Suisun during the spring bloom period which weakens evidence for the bivalve grazing hypothesis. Also summer chlorophyll concentrations began to fall prior to the introduction of *Corbula* and our observed low phytoplankton growth rates (Wilkerson et al. 2006) may be in part responsible for the

long term decline in the bay/Delta ecosystem (Jassby et al. 2002). The *Corbula* population is likely holding ambient chlorophyll concentrations to relatively low values, but the phytoplankton present are held to low growth rates by other factors. The combination ensures low primary production rates. We propose to investigate whether this low Suisun productivity is simply a consequence of the freshwater to marine transition, or a local problem of currently unknown origin. We suspect the latter, perhaps due to some local source of material toxic to phytoplankton.

Phytoplankton Communities in SFE

All three embayments (Central, San Pablo and Suisun Bays) apparently have similar phytoplankton communities (Table 1) usually made up of larger cells (Wilkerson et al. 2006) with diatoms playing a large role in the spring blooms that occur (Cloern and Dufford, 2005). In SFE these are dominated by *Skeletonema costatum, Chaetoceros* species, *Thalassiosira* species and *Coscinodiscus* (Cloern and Dufford, 2005). Diatoms thrive in the high NO_3 environments, have inherently high growth rates and are well suited to be the dominant functional group as reviewed by Cloern and Dufford (2005). Flagellate and cryptophyte cells are observed, especially during the smaller fall blooms, although red-tide species are rare, with the exception of an unprecedented red tide of *Akashiwo sanguinea (= Gymnodinium splendens*) observed in Central Bay in September 2004 (Cloern et al. 2005a, b). Apparently, different communities reside in the freshwater of the Rivers Sacramento and San Joaquin with filamentous blue green algae (e.g. *Anabaena* occurring). Lehman (pers. comm. and cited in Contra Costa Times, Oct 18, 2005) reported increased abundance of the toxin producing *Microcystis.* This alga has been observed in Suisun Bay but whether it survives year round when the region becomes more saline is not clear.

Table 1 Preliminary Phytoplankton Data (cells l^{-1}) Collected over 6 Weeks in Spring 2005

	Suisun		**San Pablo**		**Central**	
	average	maximum	average	maximum	average	maximum
Diatoms	60021	339232	188240	619600	222382	874200
Dinoflagellates			72	800	1382	2600
Cryptomonads	5330	16000	11418	68800	13745	42400
Chlorophyta	667	3200				
Blue Greens	117	600	36	400	73	800
Mesodinium	69	400	245	1200	346	2400

Summary

Suisun Bay primary productivity is low compared to two other bays downstream (San Pablo and Central Bays). This may be caused in part by the high ambient NH_4 concentrations that makes the available NO_3 inaccessible for growth (due to inhibition of NO_3 uptake). Even, with a supply of NH_4, Suisun Bay phytoplankton show low NH_4 uptake rates. Since 1999, Suisun Bay has had only one bloom, in spring 2000, in contrast to the other two bays studied by us. These results support the "Bad Suisun" hypothesis put forward by the POD Project Working Team and since phytoplankton should provide a major food source for the higher trophic levels in Suisun and the Delta the problem with low phytoplankton productivity is likely to manifest itself up the food chain. The phytoplankton may be the key driver in the "Bad Suisun" environment, signaling the unhealthy condition of this estuarine habitat. We propose to measure phytoplankton physiological rates and

community structure to assess to what extent they signal an anomalous condition in Suisun Bay, evaluate the possible drivers using experimental mesocosms and to model the effect of reducing the "bad" condition to determine if management practices aimed at this trophic level are feasible for trying to alleviate the POD.

3. APPROACH AND SCOPE OF WORK

Tasks and Schedule

The scope of work has been split into 5 tasks, all of which extend throughout the 3 year (36 month) period and closely parallel our Scientific Objectives (see **Project Purpose** Section). We have explicitly chosen to focus on phytoplankton processes and not develop a large diffuse multi-disciplinary multi-institutional approach as this would not be appropriate at this point in time until some fundamental information for this trophic level is obtained. Task 1 is required by CALFED to be the administrative task of the scope of work. Tasks 2 and Tasks 3 could be done separately although interpretation of the results of one is heavily supported by the other, and by Task 4. Similarly, Task 4 is contingent on Tasks 2 and 3 to supply the samples. Task 5 could be done separately using previously obtained data but the predictive capability of the model for the POD habitat of the Delta region would be limited.

Task 1. Project Management

This represents project oversight, data handling, preparation of reports, communicating results and progress to CALFED and outreach activities. It involves most of the personnel.

Task 2. Suisun Habitat Description

This fieldwork task will assess the anomalous Suisun habitat ("Bad Suisun") in context of the delta, upstream (into the Sacramento and San Joaquin Rivers) and downstream (a more oceanic "healthy" condition in Central Bay). Besides measuring gradients of bulk constituents (e.g. phytoplankton abundance as chlorophyll, nutrient concentration etc) which may not provide a very sensitive index, this task will focus on measuring physiological rates that respond more quickly to change (e.g. photosynthesis, nutrient acquisition, growth rate).

Task 3. Experimental Manipulations

Accompanying field measurements of the "Bad" Suisun condition, experimental enclosures will be used to manipulate the possible drivers that are causing this unique habitat. These have been used effectively to compare Suisun Bay with San Pablo and Central Bays. Here they will be used to evaluate the relative response to changing conditions (drivers) of Suisun phytoplankton growth with those from upstream freshwater and downstream, oceanic populations.

Tasks 2 and 3 involve all personnel except algal taxonomist Ed Carpenter and include both field sampling in Years 1 and 2, with laboratory based biological and chemical analyses and presentation of the data at local and national meetings and workshops in all three years.

Task 4. Phytoplankton Condition Analysis

This is specifically to support Dr E Carpenter to use light microscopy to identify and enumerate the components of the Suisun phytoplankton community giving information (especially diatom numbers) about relative food sources for the food web of delta fishes. It will also evaluate the cellular condition (or health) and look for empty, dead or unhealthy looking phytoplankton cells.

Communities upstream (in the two rivers) and downstream (Central Bay) will be analyzed as freshwater and oceanic end members for comparison with Suisun populations.

Task 5. Modeling Change

This involves an effort by R. Dugdale to model the effect of reducing the "bad" condition to determine if management practices aimed at this trophic level are feasible for trying to alleviate the POD. For example, to model how phytoplankton would respond to lowering NH_4 inputs (as would occur with advanced secondary treatment in water treatment plants) or with freshwater dilution, and establish if there would be any significant increase in lower trophic levels.

Scientific Approach for Tasks 2,3,4,5

Task 2 Suisun Habitat Description

This will extend the geographical extent of phytoplankton growth and nutrient data from that already available from Central, San Pablo and Suisun Bays into a detailed study of Suisun Bay and with sampling into the Delta and upper Delta region, to describe the pelagic habitat in comparison with oceanic (Central Bay) and freshwater (Sacramento and San Joaquin Rivers) end members. This will test Hypotheses 1and 2, and address whether Suisun is part of the freshwater to marine transition, or an anomalous habitat. If so this implies that even lower physiological rates are to be found in the direction of the Delta and the rivers. To understand whether conditions in Suisun Bay are unique and anomalous, we need to extend our measurements upstream and continue to sample an oceanic location.

Using the same techniques in use in our SFE studies for the last ten years (Wilkerson et al. 2006 and see Methods below), we will sample monthly from March to August at 4 stations (USGS stations 7, 4, 649, 657) in Suisun and the Delta using the USGS R/V Polaris (see letter of Support from Jim Cloern) beginning at the seaward end of Suisun Bay and ending at Rio Vista in the Sacramento River (Fig. 2). At the same time that these stations are sampled, a station in the San Joaquin River at Jersey Point marked JPT (Fig. 2) will be sampled with a small trailer-able boat) and a sample will be taken off the finger-pier of RTC using a clean bucket. The RTC Central Bay station and USGS station 7 in Suisun Bay (USGS 7) will also add to our historical time series of data for these embayments.

Water will be sampled at the surface and two other depths for temperature, salinity, turbidity, inorganic nutrients (NO_3, NO_2, NH_4, PO_4, $Si(OH)_4$), dissolved inorganic carbon (DIC) chlorophyll, cell size spectra using flow cytometry. DIC is required for ^{13}C experiments and provides an additional means to evaluate primary production. Salinity and temperature are obtained from the ship CTD or using a YSI probe when sampling with small boat or from the RTC finger-pier. Light attenuation coefficient, k, will be determined by secchi disk using the equation of Cloern (1990). Near surface water will be sampled for primary productivity and nutrient uptake rate measurements using $^{15}N/^{13}C$. Data analysis will enable us to see whether the low NH_4 and carbon uptake (primary production) in Suisun continues or declines upstream from Suisun Bay and determine whether the Suisun anomalies are local or part of a system wide, upstream phenomenon. (We predict/expect that phytoplankton NO_3 uptake will be essentially zero when NH_4 concentrations are above 4 μM)

Task 3. Experimental Manipulations

To supplement the characterization of the pelagic habitat description of Suisun Bay, water will be used to fill experimental enclosures (typically 20-L cubitainers incubated at 50% of surface irradiance and maintained at ambient temperature by flowing bay water on incubator tables), see Wilkerson et al. (2006), Parker (2004), Koch (2005) that are sampled daily after filling. Mesocosms experiments will be unmanipulated or manipulated experiments, in which conditions are changed and controlled, e.g. removing/replacing the phytoplankton community, changing light or nutrient conditions etc.

Enclosure experiments will be carried out monthly from March to August in conjunction with the field observations (Task 2) during years 1 and 2. In Year 1, each month water will be sampled from 4 locations ranging from oceanic (off RTC, Central Bay), to Suisun (USGS Sta 7), the Delta (USGS 649) and Sacramento River (USGS Sta 657 at Rio Vista) (Fig. 2) and used for unmanipulated mesocosms. San Joaquin River, JPT may be alternated with USGS 649. In year 2 manipulations will be employed based upon our findings in Year 1 although we will repeat and expand on the experiment reported in Fig. 1 where the resident phytoplankton are filtered from the water to be tested. The filtered water is inoculated with a mixture of cultured diatoms and cryptomonads that were originally isolated from the particular embayment and incubated and sampled for 5 days. We also plan to do a similar experiment but with a dilution series of the "bad" Suisun water to see if the inhibitory effects can be reduced or eliminated.

Water will be sampled for Task 3- enclosures- as close in time as feasible to the Task 2 but on separate cruises using the R/V Questuary as there would be insufficient sampling time and space for this on the Polaris and with a dedicated vessel the water can be quickly returned to RTC where the enclosures will be set up. The river water will be collected using a small boat in liason with the Questuary. Water will be sampled daily for temperature, salinity, turbidity, inorganic nutrients (NO_3, NO_2, NH_4, PO_4, $Si(OH)_4$), DIC, chlorophyll, cell size spectra using flow cytometry, primary productivity and nutrient uptake rate measurements using $^{15}N/^{13}C$. Analysis of these type of experiments will show whether the slow increase in phytoplankton growth rate anomaly in Suisun Bay (as demonstrated with elapsed time of sampling the enclosures) is a local or upstream phenomenon. Since DIC, PO_4 and $Si(OH)_4$ are always present in high concentrations in all parts of the bay, a lack of growth at a particular location water (Suisun in Fig. 1) points to a toxicity/inhibition problem. The geographic pattern should indicate the source, upstream or local.

Task 4. Phytoplankton Condition Analysis

As part of Tasks 2 and 3, the size spectra of fluorescent cells (~phytoplankton) will be made using a CytoSense flow cytometer that is designed for studying larger eukaryotic cells. But this does not give species composition data or observations of cellular status. During Tasks 2 and 3, water will be collected for phytoplankton identification, enumeration and cellular observation. Surface samples (from stations in Fig. 2 or the enclosures) will be collected directly into 500 ml amber glass bottles, and preserved and stained with Lugol's solution. Phytoplankton will be identified to species using the Utermohl techniques (Utermohl, 1958; Hasle, 1978) and an inverted phase contrast microscope (Nikon Type 180). In doing counts, at least 200 of the commonest species will be counted for good statistical estimation.

In addition the cellular condition of the cells will be documented. In particular we have noticed phytoplankton cells from Suisun often to be coated with particles compared with other SFE phytoplankton samples. Particular care will be made to document if cells are empty, shriveled or look abnormal in any way.

Task 5. Modeling Change

A simple model has been constructed to predict the time varying concentrations of NO_3 and NH_4 in enclosure experiments as a result of phytoplankton uptake and growth. This has been constructed using similar model structure used by Dugdale for modeling the response of phytoplankton to increased nutrient conditions in coastal and equatorial upwelling (e.g. Dugdale et al. 1990; 2002) and applied to SFE. The variables are initial NO_3 and NH_4 concentrations and the equations are governed by rates of acceleration of NO_3 uptake observed in upwelling studies (Zimmerman et al. 1986, Dugdale et al. 1990) and NH_4 inhibition of NO_3 uptake (Cochlan and Harrison, 1991). Model runs initialized with the first enclosure experiments made by Hogue (2000) have been compared with the time course of NO_3 and NH_4 depletion in these experiments. We propose to apply the model to our more recent SFE enclosures that have sampled from Suisun, San Pablo and Central Bays (Parker et al. in prep.). The main use of the model will initially be to detect anomalies from the baseline Central Bay and San Pablo Bay enclosures (Fig. 3; Conceptual Model). We have irradiance/uptake data that will be incorporated into the model, along with carbon uptake (primary production). Twenty enclosure experiments have been completed and these and the enclosures to be made in this proposed study will provide a solid data base for validation of the model. With incorporation of carbon and irradiance, the validated model would be available to be inserted into more extensive models.

An important use of the model would be to predict the changes in primary production in Suisun Bay with changes in whatever proves to be the problem of low anomalous productivity. Using results from the proposed experimental mesocosms using diluted Suisun water, the model could be used to evaluate if the Suisun ecosystem (i.e. phytoplankton physiology) can approach the Central Bay condition if the "bad" Suisun elements are removed or reduced. It is hoped that other changes, such as lowering NH_4 inputs (as would occur with changes in waste water treatment or increased freshwater flow) would impact the phytoplankton physiology (~growth) and biomass (Fig. 3).

Detailed Methods

Nutrients and Dissolved Inorganic Carbon

Primary nutrient concentrations (NO_3, NO_2, PO_4, and $Si(OH)_4$) will be analyzed with a Bran and Luebbe AutoAnalyzer II according to the procedures of Whitledge et al. (1981) for all but $Si(OH)_4$ which will use Bran and Luebbe (1999). Separate 25 ml samples will be collected for manual colorimetric determination of NH_4 (Solorzano 1969). DIC will be measured using a Monterey Bay Res. Inst.-clone DIC analyzer with acid-sparging and ND infra-red analysis (Walz & Friederich, 1996, Parker 2005).

Phytoplankton Biomass, Productivity and Nitrogen Assimilation Measurements

Phytoplankton biomass will be estimated from extracted chlorophyll-a, particulate organic N and C concentrations and by flow cytometry. Size fractionated *in vitro* chlorophyll (for cells with diameters <5 μm or >5 μm) will be determined using the extraction protocol of Arar & Collins (1992) and a Turner Designs Model 10 fluorometer. Typically the larger cells represent the diatom community. The size distribution of fluorescent particles will be made using a CytoSense flow cytometer in 20 ml samples (Dubelaar and Gerritsen, 2000). POC and PON will be determined by mass spectrometry as part of the isotope tracer experiments.

Uptake of NO_3 and NH_4 and primary production will be estimated with dual labeled $^{15}N/^{13}C$ stable isotope tracer techniques (Slawyk et al., 1977, Legendre and Gosselin, 1996) to yield simultaneous N and C uptake rates from a single sample. ^{13}C estimates of primary production are reliable and consistent with the ^{14}C method in estuaries (Parker, 2004). Water will be dispensed into 150 ml incubation bottles and inoculated with either $Na^{13}CO_3$ and $K^{15}NO_3$, or $Na^{13}CO_3$ and $^{15}NH_4Cl$ (99 at%). Additions will be made to approximately 10% of ambient concentration to avoid substrate enhancement effects. Immediately following inoculation, one sample will be filtered onto a precombusted GF/F filter (450ºC, 4-hr) by gentle vacuum to determine the initial PON and POC concentration and isotopic filter blank. Incubations at ambient temperature and 50% surface light will last 24 hours and will be terminated by gentle vacuum filtration onto precombusted GF/F filters. N and C concentration and isotopic composition will be determined using a Europa 20/20 mass spectrometer. N and C uptake rates will be calculated based on isotopic enrichment according to Dugdale and Wilkerson (1986).

Equipment and Facilities

Dugdale and Wilkerson each have an analytical chemical/biological research laboratory at RTC with appropriate small equipment. These include muffle ovens, spectrophotometers, fluorometers, balances, high precision micropipettes, filtration racks, pumps and all reagents needed for analyses of inorganic nutrients and phytoplankton biomass (chlorophyll, PON, POC etc) and isotopic abundance in samples from shipboard studies. One has a designated radioactive area for ^{14}C, ^{3}H and ^{32}Si uptake analyses. Small boats and the R/V Questuary are available for water sampling of SF Bay, and jointly shared equipment (image processing and production lab, microscopes, scintillation counters etc) are available at RTC. We have extensive water table and plexiglas incubator facilities. RTC monitoring site SFBeams (CTD, weather, fluorometer, transmissometer, PAR) is available with real-time data.

At RTC, the following major equipment owned mostly by Dugdale and Wilkerson will be used:

- Bran and Luebbe Technicon 11 AutoAnalyzer for nutrient measurements
- RTC-Joint Use PDZ Europa 20/20 mass spectrometer for measuring ^{15}N and ^{13}C enrichments and PON and POC biomass
- DIC Analytical System (duplicate of U Delaware/MBARI system)
- Barnstead NanoPure water system
- Cytobuoy Flow Cytometers designed for applications with a dynamic range for pico to micro-plankton sizes. Used to obtain size spectra and fluorescence characteristics of phytoplankton
- Zeiss inverted microscope for phytoplankton enumeration with settling chambers etc.

Expected Deliverables

Specific to CALFED*:* Semi-annual report(s) every 6 months and a final report, one page project summaries for public audience at start and end of project, presentation(s) at CALFED Science Conferences and at the request of CALFED Science Program staff and copies of all published material resulting from the grant

WebSite: Data and analyses will be available on a dedicated page on our lab website (http://online.sfsu.edu/~phytopl/)

Presentations at Workshops Seminars and Conferences: Data will be presented at the quarterly Estuarine Ecology Team meetings of the Interagency Ecological Program, and the annual IEP Workshops held in March at Asilomar and at any other local seminars/workshops held by state and federal agencies, such as DWR. We have presented our data in the past to the SFB RWQCB and the Water Quality group at USGS. Presentations will also be made at state and national conferences such as the Estuarine Research Federation Meeting in September 2007, the Biennial State of the Estuary Meeting, October 2007, ASLO in June 2008 and the CALFED Science Meeting in October 2008 (see above).

Publications: Preliminary results will be published in the IEP newsletter which is produced by the InterAgency Ecological Program. As the data is worked up in Year 3 we will prepare a manuscripts for the on-line SF journal, California Estuarine and Watershed Science and also for Estuaries and Coasts or Estuarine and Coastal Shelf Research.

OutReach: We will be involved in annual teachers workshops held each spring at RTC. We will also participate in the BayQuest Educational Program, a cooperative education experience run by The Bay Model Association, the US Army Corps of Engineers and RTC. We have been approached about developing an estuarine curricular unit that would be taught by Wilkerson or Parker at the Bay Model or on BayQuest research voyages on SFB. Currently the BayQuest Program reaches 350 bay area K-12 grade students each year and runs separate teacher training programs for as many as 70 bay area educators. We have also been asked to present our research at SF BAY NERR meetings. We will also provide lectures at the local Library Lecture Series and Rotary Club about our estuary research to educate the general public.

4. FEASIBILITY

We have had previous experience with making these measurements in SFE and in experimental enclosures (see Wilkerson et al. 2006) and have budgeted the suitable number of personnel and time to both obtain a complete and statistical appropriate data set during the first 24 months, allowing for bad weather days. The final year is to complete laboratory analyses and data processing and work up, apply the data to the modeling effort and be able to produce peer-reviewed publications that contain our findings. No environmental permits or compliances are required. This project is very focused at one trophic level within the food web within one institution and project co-ordination and management decisions would be consequently very simple and straightforward. The project staff will meet each week to discuss progress and future plans. We will profit from feedback from regional scientists (e.g. Cloern, Kimmerer, Lehman, Mueller-Solger) during periodic IEP workshops that we will use to advise us and act as external review of the project.

5. RELEVANCE TO THE CALFED SCIENCE PROGRAM

Relevance to this PSP

This proposal directly addresses a recently identified "scientific unknown" to the CALFED community articulated by the Pelagic Organism Decline Working Group of the IEP; that of understanding the "Bad" habitat conditions of Suisun Bay and evaluating whether and how phytoplankton signal this state. As such it also considers a priority research area for CALFED the Pelagic Organism Decline.

More specific to the 4 **Priority Topics** identified in the PSP the proposed research is directed towards: "**Topic 4: Habitat Availability and Response to Change** as the scope of work proposed will assess the anomalous Suisun habitat ("Bad Suisun") in context of the Delta, upstream (into the Sacramento and San Joaquin Rivers) and downstream (a more oceanic condition in Central Bay), and so contribute to delineating habitat availability for key Delta species. Understanding the way the "bad" conditions impact the lower trophic levels and modeling these will offer ways to understand community response to future changes in the Delta and northern estuary.

Within this topic our research will aid in answering all of the **Questions** listed in Topic 4 by understanding more about the quality of the Delta habitat for key species and the drivers that are responsible. Such drivers may be abiotic (e.g. climate, nutrient content etc), biotic (phytoplankton condition and growth, grazing) and anthropogenic (e.g. water flow, nutrient loading from treatment plants, chemical runoff from agricultural lands). Modeling efforts will help to determine how change will affect habitat conditions at the foodweb level.

The data produced will also provide many of the **Key Components** listed under Topic 4. Our research will yield an inventory and analysis of current habitat extent and condition, and spatially explicit data on species relative abundance, with a focus on Suisun Bay and lower trophic species essential to fuel the pelagic foodweb of the Delta. It will develop and use spatially-explicit models and databases to analyze and map the potential effects of change on the existing "Bad" habitat of Suisun.

Relevance to Other CALFED Issue sand Projects

This research proposal directly meets two overarching objectives of the CALFED-Bay-Delta Program; studying and improving ecosystem quality and water quality. The body of knowledge that we expect to generate should help guide decisions and evaluate actions critical to CALFED.

The proposed study complements other presently funded science research projects including the Delta Food Web Project led by Wim Kimmerer as it puts the lower trophic level data that has been collected into a physiological and ecological framework with reference to downstream and upstream of their study site. It directly links with the DWR study (Mueller-Solger) that is measuring phytoplankton communities using a spectrofluorometer by providing microscopic counts as ground truthing, and the Lehman study of *Microcystis* as this may be an influential player in the Suisun habitat, both as a toxic driver and as a competitor to phytoplankton that are a preferential food source. The ideas about "Bad" Suisun will likely be incorporated into the computational assessments of the Delta being made by Jim Cloern.

One of the missions of CALFED is to be able to use results from the Science Program to help manage their resources and try to solve problems such as the POD. The data obtained here may contribute to that process and the modeling component may indicate whether changes that could be made at the management level would improve conditions for the lower trophic levels and so help to ameliorate the POD. For example, if part of the problem in Suisun Bay is linked to excess or high levels of NH_4 that limit phytoplankton growth, this could be used as a management tool to improve primary productivity, since a significant proportion of the anthropogenic input of NH_4 to SFE could be controlled by changes in water treatment practices and water allocation (dilution).

Relevance to Other Estuarine Questions

The question of how NH_4 impacts estuarine productivity and health is already of interest to the San Francisco Bay Regional Water Quality Control Board (L. Kolb (lkolb@ waterboards.ca.gov) RWQCB and the San Francisco Public Utilities Commission (S. Glendening,

sglendening@sfwater.org) who are considering adding NH_4 issues to their long term planning documents.

Elements of the research should have a far-reaching impact and could be applied to other estuaries of this scale in the state and the U.S. In particular, many U.S. rivers and estuaries of the U.S. are experiencing increasing loads of NH_4 (Paerl, 1999) and our data could be applied to these impacted estuaries also. US wide this could benefit National Coastal Water Quality Management Agencies, EPA. Such data is essential for the Monitoring and Water Quality Guidelines that are constantly being updated by the EPA, e.g. the working group on Nutrient Criteria for Estuaries (R. Dugdale and J. Cloern are SFE committee members).

6. QUALIFICATIONS (Detailed CV's given on Project Staff Form)

Name	Responsibility	Experience (	Fieldwork
Richard Dugdale	Manage project (Task1).Oversee all scientific tasks (Tasks 2,3,4,5). Participate in cruises, mesocosms, lab analyses and data workup. Give scientific presentations and prepare manuscripts. Carry out Modeling (Task5)	PhD 1955 Lead PI on many multi-PI projects	40 yrs, >150 cruises
Frances Wilkerson	Has management responsibilities for all tasks, especially in the area of report preparation and submittal of CALFED deliverables (Task 1). Participate in mesocosms, lab analyses and data workup. Give scientific presentations and prepare manuscripts. Mentor graduate student	PhD 1980	20 years ~25 cruises
Edward Carpenter	Solely responsible for Task 4, microscopy-identification and enumeration of phytoplankton	PhD 1964	30 years, >70 cruises
Alexander. Parker	Contributes to data analysis for Task 1. Organizes the field program and mesocosms in Tasks 2 and 3. Primary lab responsibility is to run the mass spectrometer for $^{15}N/^{13}C$ uptake rate measurements. Give scientific presentations and prepare manuscripts. Mentor graduate student	PhD 2004	7 yrs, ~ 25 cruises
Al. Marchi	Help analyze data and prepare deliverables for Task 1. Participate in cruises and mesocosm experiments. Small boat driver. Primary lab responsibility is nutrient analyses for samples collected in tasks 2 and 3.	MA 1998	10 years ~40 cruises
Victoria Hogue	Help manage data, maintain web page and prepare deliverables for Task 1. Participate in cruises and mesocosm experiments. Primary lab responsibility is to measure chlorophyll and prepare mass spectrometry sub-samples from water collected in tasks 2 and 3.	MA 2000	12 years ~ 50 cruises
Amy Kleckner	Participates in the field and enclosure studies, Tasks, 2 and 3; carry out all DIC measurements and flow cytometry.	BSc 2006	

Organizational Structure

Postdoctoral Fellow, Parker and Senior Technicians, Marchi and Hogue report directly to PI's Dugdale and Wilkerson. Grad student Kleckner reports to Parker and Wilkerson. Carpenter provides data to Wilkerson.

7. LITERATURE

Alpine, A. E. and J. E. and Cloern. (1988) Phytoplankton growth rates in a light-limited environment, San Francisco Bay. Marine Ecology Progress Series 44:167-173.

Alpine, A. E. and J. E. Cloern (1992). Trophic interactions and direct physical effects control phytoplankton biomass and production in an estuary. Limnology and Oceanography 37: 946-955.

Arar, E. J. and G. B. Collins (1992). In vitro determination of chlorophyll a and phaeophytin a in marine and freshwater phytoplankton by fluorescence - USEPA Method 445.0. USEPA methods for determination of chemical substances in marine and estuarine environmental samples. Cincinnati, OH.

Bran & Leubbe Autoanalyzer Applications (1999). AutoAnalyzer Method No. G-177-96 Silicate in water and seawater. Bran Luebbe, Inc. Buffalo Grove, IL.

Bran Luebbe AutoAnalyzer Applications. 1999. AutoAnalyzer Method No. G-177-96

Cloern, J. E. 1982. Does the benthos control phytoplankton biomass in south San Francisco Bay (USA)? Marine Ecology Progress Series 9:191-202.

Cloern, J. E. (1984). Temporal dynamics and ecological significance of salinity stratification in an estuary (South San Francisco Bay, USA). Oceanologica Acta 7:137-141.

Cloern, J. E. (1987). Turbidity as a control on phytoplankton biomass and productivity in estuaries. Continental Shelf Research 7: 1367-1381.

Cloern, J.E. (1991): Tidal stirring and phytoplankton bloom dynamics in an estuary. Journal of Marine Research, 49:203-221.

Cloern, J. E. (2001). Our evolving conceptual model of the coastal eutrophication problem. Marine Ecology-Progress Series 210: 223-253.

Cloern, J., and A. Alpine, A. (1991). Potamocorbula amurensis, a recently introduced Asian clam, has had dramatic effects on the phytoplankton biomass and production in northern San Francisco Bay. Journal of Shellfish Research 10:258-259.

Cloern, J. E., A. E. Alpine, B. E. Cole, R. L. J. Wong, J. F. Arthur, and M. D. Ball. (1983). River discharge controls phytoplankton dynamics in the northern San Francisco Bay estuary. Estuarine, Coastal and Shelf Science 16:415-429.

Cloern, J. E., and R. Dufford. (2005). Phytoplankton community ecology: principles applied in San Francisco Bay. Marine Ecology Progress Series 285:11-28.

Cloern, J. E., T. S. Schraga, and C. Burns Lopez, (2005) Heat wave brings an unprecedented red tide to San Francisco Bay: Eos, Transactions American Geophysical Union, 86: 66.

Coan, E.V. (2002) The eastern Pacific recent species of the Corbulidae (Bivalvia). Malaclogia 44: 47-105

Cochlan, W. P. and Harrison, P.J., (1991). Inhibition of nitrate uptake by ammonium and urea in the eucaryotic picoflagellate Micromonas pusilla (Butcher) Manton et Parke. Journal of Experimental Marine Biology and Ecology 153, 143-152.

Cole, B. E. and J. E. Cloern (1984). Significance of biomass and light availability to phytoplankton productivity in San Francisco Bay. Marine Ecology Progress Series 17: 15-24.

Cole, B. E. and J. E. Cloern (1987). An empirical model for estimating phytoplankton productivity in estuaries. Marine Ecology Progress Series 36: 299-305.

Dortch, Q. (1990). The interaction between ammonium and nitrate uptake in phytoplankton. Marine Ecology Progress Series 61, 138-201.

Dubelaar, G. B.. and P. L. Gerritzen (2000). CytoBuoy: a step forward towards using flow cytometry in operational oceanography. Scientia Marina 64(2): 255-265.

Dugdale, R. C. and F. P. Wilkerson (1986). The use of 15N to measure nitrogen uptake in eutrophic oceans: experimental considerations. Limnology and Oceanography 31(4): 673-689.
Dugdale, R.C., F.P. Wilkerson and A. Morel. (1990). Realization of new production in coastal upwelling areas: a means to compare relative performance. Limnology and Oceanography, 35: 822-829
Dugdale, R.C., R. T. Barber, F. Chai, T.H. Peng, and F.P. Wilkerson. (2002). One dimensional ecosystem model of the equatorial Pacific upwelling system, Part II: Sensitivity analysis and comparison with JGOFS EqPac Data Deep-Sea Research II. 49: 2747-2769.
Dugdale, R.C., F.P.Wilkerson, V.E. Hogue and A. Marchi. (2006.) The role of ammonium and nitrate in spring bloom development in San Francisco Bay. In rvision to Estuarine and Coastal Shelf Science
Hager, S. W., and L. E. Schemel (1992). Sources of nitrogen and phosphorus to northern San Francisco Bay. Estuaries 15:40-52.
Hasle, G.R. (1978). Using the inverted microscope. pp 191-196, In A. Sournia (ed.) Phytoplankton Manual, UNESCO, Paris.
Hobbs, J. A., W. A. Bennett, et al. (2006). Assessing nursery habitat for native smelts (Osmeridae) in the low salinity zone of the San Francisco estuary. Journal of Fish Biology 69: 907-922.
Hogue V. E. (2000). Ultraviolet-B radiation effects on natural phytoplankton assemblages of Central San Francisco Bay. MA Thesis, San Francisco State University, San Francisco, California
Hogue V. E., F. P. Wilkerson, R. C. Dugdale, and A. Marchi, (2001). Phytoplankton and nutrient dynamics in Suisun, San Pablo, and Central Bays. Interagency Ecological Program for the San Francisco Estuary Newletter 14:35-41.
Hogue, V.E., F.P. Wilkerson and R.C. Dugdale. (2005). Ultraviolet-B radiation effects on natural phytoplankton assemblages of central San Francisco Bay. Estuaries 29:190-203.
Jassby A. D., J. E. Cloern and B. E. Cole, (2002). Annual primary production: patterns and mechanisms of change in a nutrient-rich tidal ecosystem. Limnology and Oceanography 47:698-712
Kimmerer, W. J., and J. J. Orsi. (1996). Causes of long-term declines in zooplankton in the San Francisco Bay Estuary since 1987, p. 403-424 In J. T. Hollibaugh (ed.), San Francisco Bay: the ecosystem. American Association for the Advancement of Science, San Francisco.
Kimmerer, W. J. (2004). Open-Water Processes of the San Francisco Estuary: from physical forcing to biological responses. San Francisco Estuary and Watershed Science [online serial]. Vol. 2, Issue 1 (February 2004), Article 1
Koch, F. (2005) Silicate Uptake and utilization by diatoms in cetra Sa Francisco Bay. MSc Thesis, San Francisco State University, San Francisco, California
Legendre, L. and M. Gosselin (1996). Estimation of N or C uptake rates by phytoplankton using 15N or 13C: revisiting the usual computation formulae. Journal of Plankton Research 19(2): 263-271.
Lehman, P. W. (2000). Phytoplankton biomass, cell diameter, and species composition in the Low Salinity Zone of Northern San Francisco Bay Estuary. Estuaries 23:216-230.
Lucas, L. V., J. E. Cloern, J. R. Koseff, S. G. Monismith, and J. K. Thompson. (1998). Does the Sverdrup critical depth model explain bloom dynamics in estuaries. Journal of Marine Research. 56: 375-415.
Müller-Solger, A. B., A. D. Jassby, et al. (2002). Nutritional quality of food resources for zooplankton (Daphnia) in a tidal freshwater system (Sacramento-San Joaquin River Delta). Limnology and Oceanography 47: 1468-1476.

Paerl, H. W. (1999). Cultural eutrophication of shallow coastal waters: Coupling changing anthropogenic nutrient inputs to regional management approaches. Limnologica 29, 249-254.
Parker, A. E. (2004). Assessing the phytoplankton-heterotrophic link in the eutrophic Delaware Estuary. Graduate College of Marine Studies. Lewes, University of Delaware: 277.
Parker, A. E. (2005). Differential supply of autochthonous organic carbon and nitrogen to the microbial loop of the Delaware Estuary. Estuaries 28(6): 856-867.
Schemel, L. E. and S. W. Hager. (1986). Chemical variability in the Sacramento River and in northern San Francisco Bay. Estuaries 9:270-283.
Slawyk, G., Y. Collos, et al. (1977). The use of 13C and 15N isotopes for the simultaneous measurement of carbon and nitrogen turnover rates in marine phytoplankton. Limnology and Oceanography 22(5): 925-932.
Solorzano, L. (1969). Determination of ammonia in natural waters by the phenol hypochlorite method. Limnology and Oceanography 14: 799-810.
Utermöhl, H. (1958). Zur Vervollkommung der quantitative Phytoplankton Methodik, Mitt. Int. Verein. Limnol. 9: 1-38.
Walz, P. M. and G. E. Friederich (1996). Rapid automated analysis of total dissolved inorganic carbon and its application in the central California upwelling system during the CoOP95 experiment. EOS 76: OS102.
Whitledge, T. E., S. C. Malloy, C. J. Patton and C. D. Wirick. (1981). Automated Nutrient Analysis in Seawater, Report BNL 51398. Brookhaven National Laboratory, Upton NY, 216 pp.
Wilkerson, F.P., R.C. Dugdale, V.E. Hogue and A. Marchi. (2006) Phytoplankton blooms and nitrogen productivity in San Francisco Bay. Estuaries and Coasts 29 (3) 401-416.
Zimmerman, R.C., J.N. Kremer and R.C. Dugdale. (1987). Acceleration of nutrient uptake by phytoplankton in a coastal upwelling ecosystem: a modeling analysis. Limnology and Oceanography 32: 359-367.

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Current Position: Senior Research Scientist, Romberg Tiburon Center
Adjunct Professor, San Francisco State University
Emeritus Professor, University of Southern California

Professional:

1950	B.S., University of Wisconsin, Electrical Engineering
1951	M.S., University of Wisconsin, Zoology and Botany
1955	Ph.D., University of Wisconsin, Zoology
1956	Post-Doctoral Fellow, Marine Institute, University of Georgia

Appointments:

1996-	Senior Research Scientist, Romberg Tiburon Center,
1994	Visiting Scientist, Institute of Marine Biology of Crete, Greece
1988-95	Consultant, Ocean Sciences, Jet Propulsion Laboratory
1987	Assoc. Scientist, CNRS, Lab. Physique & Chimie Mar., Villefranche-sur-Mer,
1981-86	Director, Allan Hancock Foundation, University of Southern California
1979-	Professor of Biological Sciences, University of Southern California (USC)
1979-83	Assoc. Dir. for Marine Sciences, Inst. for Marine and Coastal Studies, USC
1975-79	Research Scientist, Bigelow Lab. for Ocean Sciences, W. Boothbay Harbor, ME
1974-75	Consultant, World Health Organization
1972-73	Fulbright Research Fellow, Athens, Greece
1967-75	Research Professor, Department of Oceanography, University of Washington
1962-67	Associate Professor of Marine Science, University of Alaska
1960-62	Assistant Professor of Zoology, University of Pittsburgh

Honors and Awards:

Honoris Causae, University of Marseilles
Hutchinson Award, American Society of Limnology and Oceanography
Fellow, California Academy of Sciences, Fellow of AAAS
Past President ASLO
Poste-Rouge Award, CNRS

Synergistic Activities:
Member EPA Watershed Group, Convenor, AGU Chapman Conference, Greece 2003, United Nations Millenium Assessment Study 2003-4, PhD Committees, Univ. Delaware, Alaska, Marseilles; Past Chair, UNOLS, Member, NRC Board on Long-term Archiving of Ocean Data, Former Coordinator of Sea Grant Institutional Program at USC; JGR Ocean Editor Selection Panel, Hutchinson Award Committee

Five Selected Publications Relevant to this Project:

Dugdale, R.C., F.P. Wilkerson, V.E. Hogue and A. Marchi. 2007. Spring phytoplankton bloom development in San Francisco Estuary: the role of ammonium and nitrate. In revision to *Estuarine, Coastal and Shelf Science*

Dugdale, R.C., F.P. Wilkerson, A.Marchi and V.Hogue. 2006. Nutrient controls on new production in the in the Bodega Bay, California, coastal upwelling plume. In press *Deep-Sea Research II.*

Wilkerson, F.P. **R.C. Dugdale**, V. Hogue, A. Marchi. 2006. Phytoplankton blooms and nitrogen productivity in San Francisco Bay. *Estuaries and Coasts* 29: 401-416

Cloern, J. E., T. S. Schraga, C. B. Lopez, N. Knowles, R. Labiosa, **R. Dugdale**. 2005. Climate anomalies generate an exceptional dinoflagellate bloom in San Francisco Bay. *Geophysical Research Letters*, vol. 32, l14608, doi:10.1029/2005GL023321.

Hogue, V. F.P. Wilkerson and **R,C. Dugdale**. Hogue, V., F.P. Wilkerson and R,C. Dugdale. 2005 Effects of ultraviolet-B radiation on natural phytoplankton assemblages in central San Francisco Bay. *Estuaries.* 28: 190-204.

Five Significant/Recent Publications:

Takabayashi, M., K. Lew, A. Johnson, A. Marchi, **R. Dugdale**, F.P. Wilkerson. 2006. The effect of nutrient availability and temperature on chain length of the diatom, *Skeletonema costatum*. *Journal of Plankton Research* 28: 831-840

Wilkerson, F.P. **R.C. Dugdale**, A. Marchi, V. Hogue, A. Lassiter. 2007. The phytoplankton bloom response to wind events and upwelled nutrients during the CoOP-WEST Study. In press. *Deep-Sea Research II*

Lassiter, A.M, F. Wilkerson, **R.Dugdale** and V. Hogue. Functional phytoplankton groups in the CoOP-West upwelling region: the *Chaeteoceros* complex. In press. *Deep-Sea Research II*

Leynaert A., Bucciarelli E., Claquin P. **Dugdale, R.C**. Martin-Jezequel, V., Pondaven P. Ragueneau O. 2004. Effect of iron deficiency on diatom cell size and silicic acid uptake kinetics. Limnology and Oceanography 49: 1134-1143.

Dugdale, R.C. and F.P. Wilkerson. 1998. Silicate regulation of the new production in the eastern equatorial Pacific upwelling. *Nature* 391: 270-273.

Scientific Collaborators in the Past 48 Months (other than co-authors listed above):

W. Kimmerer, A. Kemp, S. Bollens, J. Largier, E. Dever, B. Ward, J. Zehr, P. Strutton, M. Brzezinski, D. Nelson, B. Balch, N. Garfield, M. Landry, P. Treguer,

Ph.D. and Post-doctoral Advisors and Advisees:

Ph.D. Advisor: J. Neess; Post-doctoral Advisor: L. Pomeroy

Graduate Student Advisees: Curt Davis, Paul J Harrison, Terry Whitledge, Lee Conway, Sung R. Yang, Raphael Kudela, Thomas Hayden, Klane White, Florian Koch, Kevin Lew

Institution:	**San Francisco State University**																						
Program Director:	**Richard Dugdale and Frances Wilkerson**																						
Title:	**Do Low Phytoplankton Growth Rates Signal the Bad Habitat Conditions in Susiun Bay Driving the Pelagic Organismal Decline?**																						
Sponser:	**Calfed**																						
Duration:	**3 years -3/01/07 -2/28/10**																						
At SFSU Personnel are paid monthly so the participation is listed in months																							
The hourly rate is provided in the master table of salaries below																							
1 month is equivalent to 173.33 hours																							
Students are paid hourly- maximum of 80 hours a month																							
Salaries are estimated to increase by 5% in Year 2 and by 10% in year 3																							
					Annual	**Monthly**	**Hourly**	**%Fringe**	**Comments**														
					Salary	**Salary**	**Salary**																
173.33	Project Director,	Richard Dugdale			$ 114,181	$ 9,515	$ 55	12.0%															
	Project Co-Director	Frances Wilkerson			$ 77,326	$ 6,444	$ 37	48.0%															
	Faculty Microscopist	Edward Carpenter			$ 117,480	$ 13,053	$ 75	12.0%	summer salary														
	Post-doc,	Alex Parker			$ 39,000	$ 3,250	$ 19	48.0%															
	Nutrient Technician	A Marchi			$ 43,050	$ 3,588	$ 21	48.0%															
	Tracer Technician	V Hogue			$ 42,000	$ 3,500	$ 20	48.0%															
	Graduate Student	Amy Kleckner				$ 1,120	$ 6	1.5%															
TASK 1:PROJECT MANAGEMENT		**TOTAL AMOUNT**	**YEAR 1**					**YEAR 2**						**YEAR 3**									
		salary+fringe	amount	#months	total salary	fringe	salary+fringe	amount	#months	total	fringe	salary+fring	amount	#months	total	fringe	salary+fringe						
Personnel			per month					per month					per month										
Project Director,	Richard Dugdale	16,798	$ 9,515	0.5	$ 4,758	$ 571	$ 5,328	$ 9,991	0.5	$ 4,995	$599	$ 5,595	$ 10,490	0.5	$ 5,245	$ 629	$ 5,875						
Project Co-Director	Frances Wilkerson	15,032	$ 6,444	0.5	$ 3,222	$ 1,547	$ 4,768	$ 6,766	0.5	$ 3,383	$1,624	$ 5,007	$ 7,104	0.5	$ 3,552	$ 1,705	$ 5,257						
Post-doc,	Alex Parker	7,582	$ 3,250	0.5	$ 1,625	$ 780	$ 2,405	$ 3,413	0.5	$ 1,706	$819	$ 2,525	$ 3,583	0.5	$ 1,792	$ 860	$ 2,652						
Nutrient Technician	A Marchi	4,185	$ 3,588	0.25	$ 897	$ 431	$ 1,327	$ 3,767	0.25	$ 942	$452	$ 1,394	$ 3,955	0.25	$ 989	$ 475	$ 1,463						
Tracer Technician	V Hogue	4,082	$ 3,500	0.25	$ 875	$ 420	$ 1,295	$ 3,675	0.25	$ 919	$441	$ 1,360	$ 3,859	0.25	$ 965	$ 463	$ 1,428						
Personnel Salary Subtotal					$ 11,376					$ 11,945					$ 12,542								
Fringe Subtotal						$ 3,748					$ 3,935					$ 4,132							
Personnel total (salary and fringe)		**47,679**					**$ 15,124**					**$ 15,880**					**$ 16,674**						
Other Costs		**TOTAL AMOUNT**	**YEAR 1**				**Total Y1**	**YEAR 2**				**Total Y2**	**YEAR 3**				**Total Y3**						
Operating Expenses (supplies,shiptime, etc)		750					$ 250					$ 250					$ 250						
Travel		1,500					$ 500					$ 500					$ 500						
Equipment		-																					
Other Costs SubTotal		**2,250**					**$ 750**					**$ 750**					**$ 750**						
Total Direct Costs		**49,929**					**$ 15,874**					**$ 16,630**					**$ 17,424**						
Indirect Costs		**12,482**					**$ 3,969**					**$ 4,158**					**$ 4,356**						
Total Costs for Task		**62,412**					**$ 19,843**					**$ 20,788**					**$ 21,781**						
TASK 2:SUISUN HABITAT DESCRIPTION		**TOTAL AMOUNT**	**YEAR 1**					**YEAR 2**					**YEAR 3**										
		salary+fringe	amount	#months	total salary	fringe	salary+fringe	amount	#months	total	fringe	salary+fring	amount	#months	total	fringe	salary+fringe						
Personnel			per month					per month					per month										
Project Director,	Richard Dugdale	39,058	$ 9,515	1.25	$ 11,894	$ 1,427	$ 13,321	$ 9,991	1.25	$ 12,489	$ 1,499	$ 13,987	$ 10,490	1	$ 10,490	$1,259	$11,749.2						
Project Co-Director	Frances Wilkerson	34,953	$ 6,444	1.25	$ 8,055	$ 3,866	$ 11,921	$ 6,766	1.25	$ 8,458	$ 4,060	$ 12,517	$ 7,104	1	$ 7,104	$3,410	$10,514.4						
Post-doc,	Alex Parker	32,419	$ 3,250	2.75	$ 8,938	$ 4,290	$ 13,228	$ 3,413	2.75	$ 9,384	$ 4,505	$ 13,889	$ 3,583	1	$ 3,583	$1,720	$5,303.0						
Nutrient Technician	A Marchi	19,459	$ 3,588	1.25	$ 4,484	$ 2,153	$ 6,637	$ 3,767	1.25	$ 4,709	$ 2,260	$ 6,969	$ 3,955	1	$ 3,955	$1,899	$5,853.7						
Tracer Technician	V Hogue	18,985	$ 3,500	1.25	$ 4,375	$ 2,100	$ 6,475	$ 3,675	1.25	$ 4,594	$ 2,205	$ 6,799	$ 3,859	1	$ 3,859	$1,852	$5,711.0						
Graduate Student	A. Kleckner	10,751	$ 1,120	3	$ 3,360	$ 50	$ 3,410	$ 1,176	3	$ 3,528	$ 53	$ 3,581	1,234.80	3	$ 3,704	$56	$ 3,760						
Personnel Salary Subtotal					$ 41,106					$ 39,633					$ 28,992								
Fringe Subtotal						$ 13,836					$ 14,528					$ 10,140								
Personnel total (salary and fringe)		**155,625**					**$ 54,992**					**$ 57,742**					**$ 42,891**						
Other Costs		**TOTAL AMOUNT**	**YEAR 1**				**Total Y1**	**YEAR 2**				**Total Y2**	**YEAR 3**				**Total Y3**						
Operating Expenses (supplies,shiptime, etc)		9,800					$ 4,150					$ 4,150					$ 1,500						
Travel		3,000					$ 1,000					$ 1,000					$ 1,000						
Equipment		0																					
Other Costs SubTotal		**12,800**					**$ 5,150**					**$ 5,150**					**$ 2,500**						
Total Direct Costs		**168,425**					**$ 60,142**					**$ 62,892**					**$ 45,391**						
Indirect Costs		**42,106**					**$ 15,035**					**$ 15,723**					**$ 11,348**						
Total Costs for Task		**210,531**					**$ 75,177**					**$ 78,614**					**$ 56,739**						

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TASK 3:EXPERIMENTAL MANIPULATIONS		**TOTAL AMOUNT**	**YEAR 1**					**YEAR 2**					**YEAR 3**							
		salary+fringe	amount	#months	total salary	fringe	salary+fringe	amount	#months	total	fringe	salary+fring	amount	#months	total	fringe	salary+fringe			
Personnel			per month					per month					per month							
Project Director,	Richard Dugdale	39,058	$ 9,515	1.25	$ 11,894	$ 1,427	$ 13,321	$ 9,991	1.25	$ 12,489	$ 1,499	$ 13,987	$ 10,490	1	$ 10,490	$ 1,259	$ 11,749			
Project Co-Director	Frances Wilkerson	34,953	$ 6,444	1.25	$ 8,055	$ 3,866	$ 11,921	$ 6,766	1.25	$ 8,458	$ 4,060	$ 12,517	$ 7,104	1	$ 7,104	$ 3,410	$ 10,514			
Post-doc,	Alex Parker	32,419	$ 3,250	2.75	$ 8,938	$ 4,290	$ 13,228	$ 3,413	2.75	$ 9,384	$ 4,505	$ 13,889	$ 3,583	1	$ 3,583	$ 1,720	$ 5,303			
Nutrient Technician	A Marchi	19,459	$ 3,588	1.25	$ 4,484	$ 2,153	$ 6,637	$ 3,767	1.25	$ 4,709	$ 2,260	$ 6,969	$ 3,955	1	$ 3,955	$ 1,899	$ 5,854			
Tracer Technician	V Hogue	18,985	$ 3,500	1.25	$ 4,375	$ 2,100	$ 6,475	$ 3,675	1.25	$ 4,594	$ 2,205	$ 6,799	$ 3,859	1	$ 3,859	$ 1,852	$ 5,711			
Graduate Student	A. Kleckner	10,751	$ 1,120	3	$ 3,360	$ 50	$ 3,410	$ 1,176	3	$ 3,528	$ 53	$ 3,581	1,234.80	3	$ 3,704	$ 56	$ 3,760			
Personnel Salary Subtotal					$ 41,106					$ 39,633					$ 28,992					
Fringe Subtotal						$ 13,886					$ 14,528					$ 10,140				
Personnel total (salary and fringe)		**155,625**					**$ 54,992**					**$ 57,742**					**$ 42,891**			
Other Costs		**TOTAL AMOUNT**	**YEAR 1**				**Total Y1**	**YEAR 2**				**Total Y2**	**YEAR 3**				**Total Y3**			
Operating Expenses (supplies,shiptime, etc)		34,000					$ 16,250					$ 16,250					$ 1,500			
Travel		3,000					$ 1,000					$ 1,000					$ 1,000			
Equipment		0																		
Other Costs SubTotal		**37,000**					**$ 17,250**					**$ 17,250**					**$ 2,500**			
Total Direct Costs		**192,625**					**$ 72,242**					**$ 74,992**					**$ 45,391**			
Indirect Costs		**48,156**					**$ 18,060**					**$ 18,748**					**$ 11,348**			
Total Costs for Task		**240,781**					**$ 90,302**					**$ 93,739**					**$ 56,739**			
TASK 4:PHYTOPLANKTON CONDITION ANALYS		**TOTAL AMOUNT**	**YEAR 1**					**YEAR 2**					**YEAR 3**							
		salary+fringe	amount	#months	total salary	fringe	salary+fringe	amount	#months	total	fringe	salary+fring	amount	#months	total	fringe	salary+fringe			
Personnel			per month					per month					per month							
Faculty Microscopist	Edward Carpenter	38,026	$ 13,052	1	$ 13,052	$ 1,566	$ 14,618	$ 13,705	1	$ 13,705	$ 1,645	$ 15,349	$ 14,390	0.5	$ 7,195	$ 863	$ 8,058			
Personnel Salary Subtotal					$ 13,052					$ 13,705					$ 7,195					
Fringe Subtotal						$ 1,566					$ 1,645					$ 863				
Personnel total (salary and fringe)		**38,026**					**$ 14,618**					**$ 15,349**					**$ 8,058**			
Other Costs		**TOTAL AMOUNT**	**YEAR 1**				**Total Y1**	**YEAR 2**				**Total Y2**	**YEAR 3**				**Total Y3**			
Operating Expenses (supplies,shiptime, etc)		400					$ 200					$ 200					$ -			
Travel		0					$ -					$ -					$ -			
Equipment		0																		
Other Costs SubTotal		**400**					**$ 200**					**$ 200**					**$ -**			
Total Direct Costs		**38,426**					**$ 14,818**					**$ 15,549**					**$ 8,058**			
Indirect Costs		**9,606**					**$ 3,705**					**$ 3,887**					**$ 2,015**			
Total Costs for Task		**48,032**					**$ 18,523**					**$ 19,436**					**$ 10,073**			
TASK 5:MODELING CHANGE		**TOTAL AMOUNT**	**YEAR 1**					**YEAR 2**					**YEAR 3**							
		salary+fringe	amount	#months	total salary	fringe	salary+fringe	amount	#months	total	fringe	salary+fring	amount	#months	total	fringe	salary+fringe			
Personnel			per month					per month					per month							
Project Director,	Richard Dugdale	33,596	$ 9,515	1	$ 9,515	$ 1,142	$ 10,657	$ 9,991	1	$ 9,991	$ 1,199	$ 11,190	$ 10,490	1	$ 10,490	$ 1,259	$ 11,749			
Personnel Salary Subtotal					$ 9,515					$ 9,991					$ 10,490					
Fringe Subtotal						$ 1,142					$ 1,199					$ 1,259				
Personnel total (salary and fringe)		**33,596**					**$ 10,657**					**$ 11,190**					**$ 11,749**			
Other Costs		**TOTAL AMOUNT**	**YEAR 1**				**Total Y1**	**YEAR 2**				**Total Y2**	**YEAR 3**				**Total Y3**			
Operating Expenses (supplies,shiptime, etc)		600					$ 200					$ 200					$ 200			
Travel		1,000					$ -					$ -					$ 1,000			
Equipment		0																		
Other Costs SubTotal		**1,600**					**$ 200**					**$ 200**					**$ 1,200**			
Total Direct Costs		**35,196**					**$ 10,857**					**$ 11,390**					**$ 12,949**			
Indirect Costs		**8,799**					**$ 2,714**					**$ 2,847**					**$ 3,237**			
Total Costs for Task		**43,995**					**$ 13,571**					**$ 14,237**					**$ 16,187**			
TOTAL COST ALL TASKS		**$ 605,751**					**$ 217,417**					**$ 226,816**					**$ 161,518**			

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BUDGET JUSTIFICATION

Overall Budget Information Relevant to all Tasks

Salaries, Fringe Benefits and Overhead: Salaries at SFSU can only be set up and paid in monthly increments (not hourly) so salaries are reported here as monthly (or fractions of a month) amounts. To convert SFSU uses 173.33 hours to be equivalent to a month of work. Students, however are paid hourly and can work a maximum of 20 hours a week. Dugdale and Wilkerson will contribute additional time (2 months each year) at no cost to this project (- see matching costs

Fringe Benefits (medical and dental insurance, unemployment insurance, vacation and sick leave, retirement, Social Security; and worker's compensation) are determined in accordance with applicable SFSU policies based on the specific title and nature of each position. These range from 1.5%, 12% and 48% of the salary amount. The indirect cost rate used here was 25% as this has been the amount set in prior CALFED proposals and may have to be re-negotiated if the proposal is funded.

Permanent Equipment is not requested in this proposal.

Task 1 Project Management

Personnel: Part-time support (0.5 months each year) is requested for Drs, Dugdale, Wilkerson and Parker, and technicians Al Marchi and Vickie Hogue (0.25 months each year) to work up data collected as part of this project and prepare data reports and CALFED technical deliverables (i.e. bi-annual reports, final report, project summaries for the public, requested presentations). In addition these five will present results at CALFED Science Conferences and state and national level conferences (see deliverables). Dugdale, Wilkerson and Parker will participate in Outreach activities as described in the proposal. Dugdale will be responsible for Project Oversight. Support for manuscript preparation and participation in national conferences and workshops is included under the specific tasks that will generate these data.

Operating expenses: $250 per year are requested for communication costs and office supplies

Travel expenses: $500 per year are requested for in-State trips to present results locally, meet with CALFED officials etc.

Task2 Suisun Habitat Description (Field)

Personnel: This task requires sampling on six cruises each, during Years 1 and 2 with sampling in northern SFE, aboard the R/V Polaris and a small boat in the San Joaquin River and from the RTC pier. 2.75 months per field year salary is requested for Postdoctoral Fellow Alex Parker who will oversee this fieldwork and participate in all Polaris cruises. He will also be responsible for carrying out rate measurement incubations and the mass spectrometry of the samples that result. In this he will be helped by technician Vickie Hogue (requesting 1.25 mos/field year) who will prepare samples and help maintain the instrument. She will also be responsible for all chlorophyll analyses. -years 1 and 2).

Technician Al Marchi (1.25 mos/field year) will conduct sampling with the small boat in San Joaquin River and will be responsible for all nutrient analyses NO_3, NO_2, $Si(OH)_4$, PO_4 and NH_4measurements). Graduate student Amy Kleckner (3 months at 20h/week) will also participate in Polaris cruises and in lab will be responsible for all DIC and flow cytometry analyses. Frances Wilkerson or Richard Dugdale (1.25 mos requested per year) will sample at the RTC site and participate in other sampling if needed or provide logistical help-driving etc. They will oversee data processing and presentation and manuscript preparation. In Year 3- analysis year- all personnel request drop to 1 month to finish chemical analyses and start to prepare publications and presentations.

Operating Costs; We estimate that annually (Years 1 and 2), field work supplies that include disposables, isotope, chemicals for these six cruises with six locations (See Scope of Work)would cost $3000, ship time at $900 (6 days at $150 for small boat use) and publication costs for workshop presentations etc at $250. In Year 3 these costs would only include publication costs (page charges etc) at $1500.

Travel: Estimated at $1000 per year for partial support of personnel towards participation in local and national meetings.

Task 3 Experimental Enclosures

Personnel: This task requires sampling on six cruises each year, during Years 1 and 2 at 4 locations with sampling in northern SFE aboard the R/V Questuary, the rivers using a small boat and off the RTC pier. 2.75 months per field year salary is requested for Postdoctoral Fellow Alex Parker who will oversee the fieldwork, set up mesocosm experiments and participate in all Questuary cruises. As in Task 2, He will also be responsible for carrying out rate measurement incubations and the mass spectrometry of the samples that result. In this he will be helped by technician Vickie Hogue (requesting 1.25 mos/field year) who will sample the enclosures daily, prepare mass spectrometry samples and be responsible for all chlorophyll analyses. -years 1 and 2). Technician Al Marchi (1.25 mos/field year) will conduct sampling with the small boat in San Joaquin River and will be will e for all nutrient analyses NO_3, NO_2, $Si(OH)_4$, PO_4 and NH_4measurements). Graduate student Amy Kleckner (3 months at 20h/week) will also help with set up and daily sampling of the mesocosms and be responsible for all DIC and flow cytometry analyses. Frances Wilkerson or Richard Dugdale will take initial samples at the RTC site and participate in daily sampling of mesocosms or provide logistical help-driving etc. They will oversee data processing and presentation and manuscript preparation. In Year 3- analysis year- all personnel request drop to 1 month to finish chemical analyses and start to prepare publications and presentations.

Operating Costs; We estimate that annually (Years 1 and 2), field work supplies that include disposables, isotope, chemicals for these six cruises with four locations (See Scope of Work) followed up by daily sampling on the mesocosms for up to a week would cost $11,5000, ship time at $3600 (6 days of Questuary use at $600/day and 6 days at $150 for small boat use) and publication costs for

workshop presentations etc at $250. In Year 3 these costs would only include publication cots (page charges etc) at $1000.

Travel: Estimated at $1000 per year for this Task for partial support of personnel towards participation in local and national meetings.

Task 4. Phytoplankton Condition Analysis

This is specifically to support Dr E Carpenter and we are requesting one month summer salary each year (Years 1 and 2) to count and identify phytoplankton and $200 each of years 1 and 2 for microscope maintenance, purchase of settling chambers, Lugol's etc. In Year 3, the budget requested is only for 0.5 month salary to work up the data for the final report.

Task 5. Modeling Change

This Task is budgeted for one month salary each year for R. Dugdale who will carry out this Task. We also request $200 per year operating cost to cover computer software, computer supplies. In Year 3, travel is requested at $1000 so that the modeling results can be presented at a national meeting.

MATCHING FUNDS

Matching Funds for this project from RTC, SFSU include salary support for the two PI's and vehicle use and communication and publication costs that are supplied to funded PI's by RTC.

Dr R. Dugdale and Dr F. Wilkerson will contribute as matching costs, two months salary each year each PI spread over the Tasks as seems appropriate.

Automobile costs (for towing boats and transfer of personnel) and boat gas are also provided to funded PI's by RTC at no cost.

RTC personnel are offered use of the R/V Questuary at a reduced rate ($600/day) compared to outside users.

Communication (telephone, fax, internet services) and Publication Costs (Report and poster presentation printing) are estimated at $1000 per PI, totally $6000 for this Project.

California Home

Signature

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

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

The individual signing below declares that:

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

Proposal Title:	Do Low Phytoplankton Growth Rates Signal the "Bad" Habitat Conditions in Susiun Bay Driving the Pelagic Organism Decline
Proposal Number:	2006.01-0065
Applicant Organization:	San Francisco State University
Applicant Contact:	Dr Kenneth Paap

Applicant Signature **Date**

IC Page

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Anke Mueller-Solger, Ph.D.
Staff Environmental Scientist
California Department of Water Resources, Division of Environmental Services
901 P Street, PO Box 942836, Sacramento, CA 95814-6424
Office: (916) 651-0179; Fax: (916)651-0209; amueller@water.ca.gov

08-30-2006

Re.: Support letter for 2006 Calfed Science Program Proposal by R. Dugdale and F. Wilkerson.

To Whom it May Concern:

I am writing in support of the research proposal by **Richard Dugdale and Frances Wilkerson*: "Do Low Phytoplankton Growth Rates Signal the "Bad" Habitat Conditions in Suisun Bay Driving the Pelagic Organismal Decline?"***

As a Staff Environmental Scientist with the California Department of Water Resources, co-chair of the 2006 Calfed Science Conference, and member of the IEP Pelagic Organism Declines (POD) Investigations Management Team, I am intimately familiar with research and management needs and accomplishments in the San Francisco Estuary and its watershed. The recent and as yet unexplained drastic declines in several species of pelagic fishes and other organisms in this system have highlighted the need for more innovative and process-oriented studies aimed at investigating the causes of the declines and informing potential management actions for halting and/or reversing the POD trends. The study proposed R. Dugdale and F. Wilkerson would fill an important gap in our knowledge of ecological processes implicated in the POD trends, namely productivity disruptions at the base of the pelagic food web. This study would also complement long-term phytoplankton monitoring conducted by the IEP as well as my own ongoing Calfed-sponsored project investigating phytoplankton communities in the San Francisco estuary using and testing new submersible spectrofluorometer technology.

Preliminary results of studies coordinated by the POD team point to food limitation as one of the mechanisms leading to the recent precipitous declines of several important fish species in the Delta. In particular, the "*Bad Suisun Hypothesis*" singles out Suisun Bay as a historically important fish nursery area where food resources may have become limiting.

Previous work by R. Dugdale and F. Wilkerson showed that phytoplankton nutrient uptake, growth, and productivity rates appear to be greatly inhibited in the Suisun area relative to San Francisco Bay and points to adverse water quality conditions for phytoplankton production in the Suisun area as a possible cause for the POD trends. The proposed study would extend this work to include upstream Delta areas and a more in-depth examination of the drivers and mechanisms behind the observed phytoplankton process rates. In addition, the proposed study would also evaluate the composition and condition of the phytoplankton community in Suisun Bay relative to other regions of the San Francisco estuary. This would provide important information about the nutritional value and viability of the phytoplankton community that could be used to test POD hypotheses related to nutritional quality and quantity of food resources in the Suisun region and elsewhere. Finally, the proposed project would also include a modeling element aimed at providing insights into phytoplankton responses to water quality changes resulting from various management actions. Model results could be used by managers to evaluate different ecosystem restoration and resource management actions.

In summary, I believe that the proposed research will likely make a major contribution to addressing current pressing research and management needs such as understanding and addressing the causes of the Delta species declines, help with ecosystem restoration planning and resource management actions, and provide information that will complement other studies and monitoring programs. I highly recommend it for funding by the Calfed Science Program.

Sincerely,

(electronically)
Anke Mueller-Solger

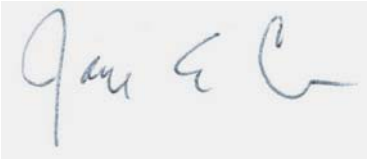
Dr. Richard Dugdale
Romberg Tiburon Centers
San Francisco State University
3152 Paradise Drive
Tiburon, CA 94920-0855

Dear Dr. Dugdale:

I am writing in support of your research proposal “Do Low Phytoplankton Growth Rates Signal the “Bad” Habitat Conditions in Suisunn Bay Driving the Pelagic Organismal Decline?”. As we discussed we are happy to collaborate as we do currently and would willing to have one of your personnel on our regularly scheduled cruises on San Francisco Bay.

The idea that the presence of high NH_4 concentrations in San Francisco Bay is responsible for reduced primary production is innovative and could lead to new insights on our understanding of biological productivity in the Bay. I am impressed with the progress you have made since you first suggested this concept at the seminar you gave at USGS a few years back. Your discovery of anomalous low phytoplankton growth rates in Suisun Bay is especially interesting in view of the newly stated “Bad Suisun Hypothesis” for the decline of the pelagic organisms in the upper San Francisco Bay.

I wish you great success with this exciting project.



James Cloern
Senior Research Scientist
USGS, Menlo Park, CA