Please send a short summary of your proposed project using the following IEP Workplan template to Anke Mueller-Solger, Kelly Souza, and Gregg Erickson as well as the IEP staff person(s) assigned to your project by November 30, 2012.

Dugdale: How do interacting dynamic and stationary habitat components affect phytoplankton physiological status and ability to form blooms in the low salinity zone?

Point person: [List IEP staff person(s) assigned to your project]
Erwin Van Nieuwenhuyse, Reclamation
Anke Mueller-Solger, DSC

Lead IEP Agency: [Leave blank]

Questions: [List main questions to be addressed]

1. Specific questions the task seeks to address

Q1a What are the full ranges (i.e. interannual variability) of dynamic abiotic (flow, nutrient concentrations) and biotic (phytoplankton biomass, condition) habitat components of the LSZ in spring and fall?

Q1b What are the rates of primary production and phytoplankton NO_3 and NH_4 uptake in the LSZ during the spring and fall period and how is this related to ambient nutrients, location and X2?

Q1c What values of quantum yield (Fv/Fm) and physiological impairment levels occur in the LSZ during the spring and fall period and how is this related to nutrient concentration and uptake?

Q1d Are phytoplankton blooms associated with a) lower NH_4 concentrations and b) frontal areas?

Description: [Describe your project and individual tasks in no more than two succinct paragraphs] Two Tasks

At present, a complete physiological understanding of bloom formation in the LSZ (Suisun Bay) is lacking, but it is likely that phytoplankton are generally physiologically impaired and during bloom periods whatever drives that impairment is reduced in the environment. We will use high resolution temporal and spatial sampling of the LSZ and large scale (200-L) enclosures to determine the conditions for phytoplankton bloom development, and employ variable fluorescence technology (Phytoflash) to link phytoplankton physiological status with dynamic and stationary habitat elements for model development and validation. Our conceptual model is that for blooms to occur there must be: 1) abundant light, 2) low NH_4 (likely reduced NH_4 discharge), 3) flows of a range to enable dilution but avoid phytoplankton washout, and 4) phytoplankton cells in good physiological condition, allowing access to the larger pool of DIN (NO_3). Algal physiology is important, but even if phytoplankton are in good physiological condition there must be the right physical and chemical environment. Photosynthetic efficiency (quantum yield) can be used to assess the physiological condition of phytoplankton. We hypothesize that quantum yield (obtained with the Phytoflash) may be used to assess: 1)

physiological state of phytoplankton in situ under various nutrient conditions and 2) the probability of phytoplankton bloom initiation. However ther are no published measurements using Phytoflash in turbid estuaries and this project would test if the variable fluorescence is actually measuring physiological condition.

Task 1: Mapping surveys in the LSZ. In spring and fall 2013 we will sample 5 transects along a range of conditions from impaired (expected in Rio Vista) to unimpaired ("control") in Central Bay, to obtain a sufficient spectrum of flow and nutrient conditions for bloom development. We will continue our measurements of nutrients, phytoplankton, carbon and nitrogen uptake rates but add phytoplankton quantum yield. Task 2: Determination of quantum yield and physiological status in experimental enclosures. These large (200-L) and small (20-L) enclosure experiments will be conducted to measure quantum yield response and phytoplankton uptake rates of NH_4, NO_3, C by phytoplankton communities in LSZ and Central Bay water of different conditions (collected at different locations). We will also manipulate conditions by adding nutrients (especially NH_4 and NO_3). These experiments will provide data to validate our conceptual model of bloom initiation and establish if a robust relationship exists between quantum yield and algal nutrient physiology (e.g. is there different quantum yield with uptake and growth on NH_4 versus NO_3, or nutrient limitation) that can be used to interpret the transect data from Task 1.

Time period: [e.g. January 2013 to December 2013 – note that this may change due to contracting requirements]

January 2013 to December 2012
If funds are available, another year of study to provide a full 5 year data base that would ensure a wider variety of flow and habitat conditions

Resources and permits required:

Cost: [Total cost]
Total cost of $230,792 (incl. 54% IDC, could potentially be reduced to 25%, and SFCWA cost share of $70,000).

PI(s): [List names and affiliations of all principal investigators]
Richard C. Dugdale; Frances Wilkerson and Alex E Parker
Romberg Tiburon Center, SFSU

Contract needed / in place: [Leave blank]

Contract manager: [Leave blank]

Term of contract: [Leave blank]

Personnel: [List names and titles of all personnel involved with this project]
Richard Dugdale. Senior Research Scientist, PI
Frances Dugdale, Senior Research Scientist,
Alex Parker, Research Scientist
Sarah Blaser, Research Technician
Adam Pimenta, Research Technician

Nicole Travis: MSc graduate student
Victoria Hogue: data technician

Equipment: [List all new equipment needed for this project]
None

Endangered species take: [If applicable, give number of Federal and State ESA-listed species specimens required by this project. Indicate life stage (larval, juvenile and adult) and hatchery or wild origin.]
None

Endangered species take permit(s) and conservation benefit: [If your project will take ESA-listed species, identify the expected conservation benefit of your project and how you will obtain the necessary take permit(s).]
None

Deliverables and dates:
[Provide bulleted list of all intended deliverables with dates.]
Date may change depending on start date.

- Final report December 2013
- IEP (or EET) presentation March 2013 or September 2013 respectively (describing project and raw data but not including analysis
- Draft manuscript December 2013 to include earlier data from LSZ with data from this project
- MSc thesis May 2014 using data collected.

Which priority research topics and questions listed in the 2012 Call for Study Concepts does this project address? [Give the primary topic and question addressed by your project. If your project addresses more than one topic or question, list all topics and specific questions that will be addressed, starting with the topic and question most central to your project. See http://www.water.ca.gov/iep/archive/2012/spotlights.cfm for the topics and questions.]

Research Topic 2: Physical and chemical habitat effects on fish populations.
Question 2C. What is the occurrence and distribution of NH_4 in relation to fish food in the estuary, and how is it affected by the interaction of stationary and dynamic habitat components?
Question 2D. What are the distribution, transport, fate, concentration, and effects of NH_4 on food in the LSZ, and how affected by the interaction of stationary and dynamic habitat components?
Question 2E. How do interacting dynamic and stationary habitat components affect seasonal nutrient patterns in the estuary?

Research Topic 3: Food web effects on fish populations (bottom-up effects).
Question 3A. To what extent are native fish limited by food supply?

Expected contribution to improving basic scientific understanding: [Briefly explain how you think your project will advance
a) the field of ecology or hydrology in general and
b) address scientific uncertainties in the Bay-Delta system - no more than one paragraph.]

a) There are no publications (to our knowledge) that have used quantum yield estimates (using variable fluorescence technology) to evaluate nutrient stress due to growth on different chemical forms of N. Making these measurements in combination with nutrient uptake and primary productivity rates in experimental enclosures and field transects will advance that understanding.
b) There are still uncertainties of what controls phytoplankton bloom initiation in the Bay-Delta system. Intensive sampling of LSZ in spring and fall will contribute more data to determine why occasional phytoplankton blooms have occurred in spring and fall and what combination of chemical and physical factors allow that to happen. Nutrient uptake data will corroborate preliminary data showing the conditions for bloom initiation but will include physiological status With a spectrum of conditions and data the bloom development can better be modeled.

Expected contribution to improving the scientific basis for Bay-Delta policy and management: [Briefly explain how you think your project will inform
a) current management and regulatory actions, plans, or opinions (e.g. Water Project Operations, BDCP, DSC Delta Plan, SWRCB Bay-Delta Plan, NOAA and FWS Biological Opinions),
b) improve monitoring to track ecosystem health and/or performance of ecological management actions, and/or c) contribute to scientific aspects of adaptive management plans (e.g. Fall Low Salinity Habitat Adaptive Management).]

a) Results will inform the Nutrient Science &Management Strategy for SF Bay, the Suisun Bay Modeling effort by SFEI. The role of NH4 in bloom formation and links with bottom up effects on delta smelt and the POD is of interest to most of these agencies, since NH4 is a habitat component that can be managed and regulated. These results will inform nutrient monitoring, management and modeling efforts directed at nutrient numerical endpoints.

b) The project will evaluate the efficacy of the Phytoflash as a monitoring tool for assessing phytoplankton performance in the SFE. Our transect data will interact with other DWR and USGS monthly monitoring in Suisun Bay although our proposal is for greater time and space scale of sampling and to include phytoplankton rates and physiology. Resource management agencies seek to identify the causes of the recent decline of pelagic fish species (Pelagic Organism Decline, POD) to enable efforts for recovery. This project will contribute scientific information for management decisions.

Comments: [E.g. relationship with other previous, ongoing, or new studies.]

Closely related to our spatially and temporally intensive datasets collected in the LSZ as part the foodweb study (2006, 2007, 2008), our Sacramento River study (CVRWQB, SWC (2008 and spring 2009), SWAMP study funded by SFRWQCB (spring 2010, 2011, 2012) and Fall Habitat and FlaSH Study funded by IEP (fall 2010, 2012) and Nutrient Ratios enclosure study (Glibert PI, funded by Bay Delta Science 2011, 2012, and planned for 2013). Closely related to other IEP funded 2013 Projects (we have been in email contact): Senn, SFEI, nutrient sources; Kraus, USGS transects with and without SRWWTP effluent discharge; Berg et al. Phytoflash in SF bay algal unicultures, Glibert and Cornwall clam and sediment mesocosms