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.

Point person:
Louise Conrad, DWR
Karen Gehrts, DWR
Anke Mueller-Solger, DSC

Lead IEP Agency:
DWR

Questions:

This study will quantitatively explore the role the Delta plays in transforming, assimilating, and removing nutrients (ammonium, nitrate, phosphate), an investigation which is critically needed to inform important and potentially costly management decisions aimed at reducing nutrient loads to the Delta and Suisun Bay. Specific questions to be addressed include:

- How have nutrient concentrations varied spatially, seasonally, and over time throughout the Delta over the past 4 decades (1975-2011; 22 DWR-EMP stations)? What are the major drivers of those changes?
- What processes have the greatest influence over nutrient concentrations, speciation, fate, and movement within and efflux from the Delta?
- How do these processes vary seasonally and spatially in their magnitude and relative importance?

Description:

The IEP's conceptual model for the Pelagic Organism Decline (POD) recognizes that multiple factors may be acting in concert to degrade habitat and contribute to the sudden decline in native and non-native pelagic fish species (Baxter et al., 2010). Anthropogenic nutrient loads are considered one potential factor, with elevated ammonium (NH4) concentrations potentially inhibiting primary productivity (Dugdale et al., 2007; Parker et al., 2012) and contributing to the increased frequency of *Microcystis* blooms in the Delta (Lehman et al., 2008). Changes in nutrient ratios and forms of N have been hypothesized to be exerting additional bottom-up pressures on Delta and Suisun food webs (e.g., Glibert et al., 2011).

Although the Delta receives high nutrient loads from treated wastewater discharges (e.g., Jassby 2008) and from agriculture in the Central Valley (Kratzer et al., 2011), there has been limited systematic study of nutrient processing within the Delta to quantify the relative importance of transformations (nitrification, uptake), removal (denitrification), and internal loads or new sources of nutrients within the Delta. Quantifying the importance of these processes is critical for understanding observed concentrations throughout the Delta, which in turn influence phytoplankton response (primary production, biomass, and community composition including harmful algal blooms), and ultimately affect nutrient loads from the Delta to Suisun Bay

This project will synthesize long-term nutrient-related monitoring data from DWR-EMP sites within the Delta (1975-2011 or 2012, depending on data release dates) and existing stable isotope data from 2005-2012, and apply hydrodynamic and water quality models, to characterize the role the Delta plays in transforming, assimilating, and removing various nutrients. Specifically, this project will:

- Identify long-term and seasonal trends in nutrient form (e.g., NH4 vs. NO3), concentrations, and ratios, and explore the factors contributing to spatial, seasonal and temporal variability;
- Enhance the calibration of a reactive transport model (DSM2-QUAL) using existing stable isotope data collected at numerous sites in the Delta and its tributaries;
- Apply DSM2-QUAL to characterize and quantify nutrient transformations and losses during transit through the Delta under a range of flow conditions;
- Quantify nutrient loads to the Delta and loads from the Delta to Suisun Bay; and
- Identify additional monitoring and special studies needed to address critical data gaps.

While the primary focus of this work is on nutrients, phytoplankton production and nutrients are tightly coupled in nature, and both sets of variables and their interdependence are parameterized in DSM2-QUAL. A more sophisticated phytoplankton-nutrient model may be needed in the future, and this project will provide key building blocks that will inform subsequent efforts.

Time period:

January 2013 through December 2013

Resources and permits required:

Cost:
$181,000

PI(s):
David Senn, San Francisco Estuary Institute (SFEI)
Carol Kendall, USGS
Marianne Guerin, Resource Management Associates (RMA)

Contract needed / in place:
Contract manager:
Term of contract:

Personnel:
David Senn, San Francisco Estuary Institute (SFEI)
Carol Kendall, USGS
Marianne Guerin, Resource Management Associates (RMA)
Megan Young, USGS
Emily Novick, SFEI

Equipment:
None

Endangered species take:
None

Endangered species take permit(s) and conservation benefit:
N/A

Deliverables and dates:

- Database of relevant nutrient and flow data used in this project that will be made publicly available to managers and other researchers (Q1 2013)
- An updated calibrated and validated DSM2 nutrient model, including boundary conditions and documentation of model extensions and revisions that will be made publicly available and given to DWR-DMS along with a technical report (Q2 2013)
- Overall project Technical Report (Q3 & Q4 2013)
- A journal manuscript describing key findings (Q4 2013)

Which priority research topics and questions listed in the 2012 Call for Study Concepts does this project address?

This study will address Priority Research Topic 2, "Physical and chemical habitat effects on fish populations" and the following specific research questions:

2C. What is the frequency of occurrence and distribution of acute and chronic toxicity of ambient water to fishes and their food items in the estuary, and how is it affected by the interaction of stationary and dynamic habitat components?

2D. What are the distribution, transport, fate, concentration, and effects of contaminants including pesticides, ammonia, and metals that may have lethal or sublethal effects on fishes and their food items in the estuarine low-salinity zone, and how are these affected by the interaction of stationary and dynamic habitat components?

2E. How do interacting dynamic and stationary habitat components affect seasonal nutrient patterns in the estuary?

Expected contribution to improving basic scientific understanding:

The Sacramento-San Joaquin Delta and Suisun Bay are highly altered ecosystems with complex hydrology and biogeochemistry. The Sacramento and San Joaquin Rivers carry substantial loads of nutrients derived from agriculture in the Central Valley (Kratzer et al., 2011) and from treated wastewater effluent (Jassby 2008) to the Delta. Quantifying these loads to the Delta is relatively straightforward. However, flows from these rivers subsequently traverse a complex network of Delta channels during which time additional nutrient loads (agriculture return flows, wetland drainage, stormwater flows), substantial transformations (nitrification, uptake; e.g., Parker et al., 2012), and losses (e.g., denitrification, settling of particle-complexed P) occur. We hypothesize that these internal processes, which are currently poorly characterized, are quantitatively important and have a large impact on both observed concentrations within the Delta and loads to Suisun Bay.

Despite the hurdles to understanding nutrient dynamics in the Delta, there exists an excellent network of long-term nutrient monitoring data (i.e., Bay-Delta EMP), which we will use to explore changes in space and time in the Delta and develop mechanistic understanding of nutrient processing within the Delta. Abundant stable isotope data also exist from several transect-scale source and transformation studies (e.g., Kendall-Guerin collaborations), and these data and the knowledge gained from the studies can be applied to investigate sources and transformations at larger spatial scales. Finally, after refining the calibration of DSM2-QUAL, we will use it to characterize and quantify nutrient transformation and loss processes in the Delta, and how they have varied seasonally, spatially, and over time during the past 35 years. Developing this

mechanistic and quantitative understanding is essential for assessing the Delta's natural ability to "assimilate" nutrient loads, and to predict how nutrient concentrations – and phytoplankton response – in the future in response to management decisions or environmental change.

Expected contribution to improving the scientific basis for Bay-Delta policy and management:

Recent studies have suggested that increases in anthropogenic nutrient loads over the past few decades, in particular ammonium, may be exerting adverse pressure on Delta and Suisun Bay ecosystems and may be contributing to the POD. Beyond on-going studies that are aiming to identify the concentrations of nitrate, ammonium, or phosphate that may cause adverse impacts, mechanistic and quantitative tools need to be developed and applied to assess the Delta's current ability to assimilate nutrient loads, and to "back calculate" from acceptable concentrations to allowable loads. The development of these tools and their application within this project will inform potentially costly management decisions within the Delta and in Suisun Bay, which receives a substantial portion of its nutrient loads from the Delta. This project will also identify critical monitoring or special study gaps that need to be addressed in order to reduce uncertainties and thereby better inform management decisions.

Comments:

This project will interact with and provide data input for multiple ongoing studies and programs: San Francisco Bay Nutrient Strategy Studies; Delta Regional Monitoring Program Development; SFRWQCB and CVRWQCB nutrient science plans for the Delta and Suisun Bay; on-going Delta and Suisun POD and habitat-oriented studies funded by multiple organizations with complementary goals; and recent IEP FLaSH studies.