Executive Summary

Biomass and toxicity of a newly established bloom of the cyanobacteria *Microcystis aeruginosa* in the Sacramento-San Joaquin Delta and its potential impact on beneficial use

Project Purpose: The goals of this research are to 1) determine the impact of the newly established large colonial form of the toxic cyanobacteria (bluegreen algae) *Microcystis aeruginosa* (*Microcystis)* on ecosystem structure and function, human and wildlife health and environmental conditions in the Sacramento-San Joaquin River Delta (Delta) and 2) use this information to make recommendations for developing an appropriate monitoring program and to provide information needed for development of effective management strategies for long-term CALFED restoration of water quality and freshwater habitat in the Delta.

These goals will be achieved by an adaptively-managed and hypothesis-driven three-year field and laboratory research program that will determine the distribution, biomass, toxicity, human and wildlife health risks and ecosystem impacts of the bloom of the toxic *Microcystis* bloom that first appeared throughout the Delta in 1999. This information will be used to quantify the magnitude and direction of mechanistic processes hypothesized to be important in a suite of conceptual models that suggest *Microcystis* affects 1) drinking water quality through organic carbon production that affects THM production and taste and odor problems and through toxicity by the production of microcystins, powerful hepatotoxins that cause liver cancer in humans and wildlife, 2) ecosystem structure and function through impacts on water quality such as light attenuation and water temperature that affect the quantity and quality of phytoplankton and food web organisms they support, 3) ecosystem structure and function through organic carbon impacts on physical and chemical processes such as visual feeding success, habitat quality and zooplankton vertical migration, and 4) ecosystem structure and function through toxic contaminant impacts on species health and survival that affects biomass and species composition throughout the food web. Additional conceptual models will be refined that address the factors that control *Microcystis* biomass and toxicity and suggest that *Microcystis* growth is favored in shallow fresh water habitat in the central Delta.

The project goals support the over-arching hypotheses 1) that the organic carbon and toxicity associated with the new large colonial *Microcystis* bloom changed the ecosystem structure and function in the Delta after 1999 and poses a continuing health threat to both humans and wildlife that will interfere with restoration efforts in the Delta and 2) that information on the spatial and temporal variation of the bloom carbon, its toxicity and toxic pathways in the food web can be used to reduce or manage the harmful impacts of the bloom on Delta beneficial use and restoration.

Questions to be addressed that support these hypotheses include: When and where are the bloom biomass and toxicity highest? How toxic is the *Microcystis* bloom to humans and aquatic wildlife on acute and chronic time scales? Is the biomass or toxicity increasing over time? What environmental factors control bloom development? How prevalent is the occurrence of *Microcystis* toxins in the food web and is the toxicity increasing over time? What are the trophic pathways for *Microcystis* toxins? What is the primary source of the bloom? How could the bloom be controlled or reduced? What is the best way to sample and monitor the bloom?

Project description: The impact of the *Microcystis* bloom on the Delta ecosystem and its causal factors will be addressed through three tasks. **Task 1** is a literature review of library and internet sources that will produce a web-based database containing current information on the acute and chronic effects of the microcystin toxins in the Delta *Microcystis* bloom on humans and wildlife. This review will focus on determining the health risk associated with the current level of toxicity and bloom biomass on humans and wildlife, levels of microcystins or biomass that create a human and ecosystem threat and possible management strategies. **Task 2** is a three year adaptively-managed and hypothesis-driven field program and historical data analysis that will determine the spatial and temporal variability and environmental conditions that influence bloom biomass and toxicity. The field program will include assessment of *Microcystis* toxins in the food web and pathways of toxin transfer. This task will also include an historical data analysis of the 30-year Interagency Ecological Program Estuarine Monitoring Program (EMP) database to determine factors that contributed to the bloom initiation and development in the late 1990s and any apparent impacts on biological communities and water quality. The field program will be adaptively managed on a yearly basis to focus questions on key habitats or time periods associated with high bloom biomass or toxicity and determine their cause. **Task 3** is a fish bioassay that will test the potential chronic impact of *Microcystis* toxins to fish health and survival from ingestion of microcystins in the Delta bloom at various levels as well as those currently in the food web.