Executive Summary

The causes of the recent decline in pelagic fish density and long-term decline in fishery resources in the delta and Suisun Bay of the San Francisco Estuary are unknown. It is hypothesized that both total biomass and species composition of phytoplankton and zooplankton at the base of the food web are important contributing factors. Quantifying the density and biomass of phytoplankton and zooplankton species, identifying the presence of exotic plankton species introductions, monitoring the development of harmful algal bloom species, developing predictive and mechanistic models of lower food web dynamics and developing rapid adaptive management of phytoplankton and zooplankton resources is limited by the low frequency spatial and temporal resolution of phytoplankton and zooplankton field sampling and the lengthy processing time and high cost of phytoplankton and zooplankton species samples. This project uses the new imaging-in-flow instrument, FlowCAM®, a portable flow cytometer with confocal microscopy and a chlorophyll fluorescence probe to identify, count and estimate the biomass of plankton organisms in situ. The FlowCAM® will be used 1) in field and laboratory studies in combination with historical data analysis to quantify the high frequency spatial and temporal variation in phytoplankton and zooplankton species composition, density and biomass and determine their relation to each other and to water quality conditions in habitats critical for key pelagic organisms and 2) to develop state-of-the art monitoring methods that provide accurate, reliable and rapid measurement of phytoplankton and zooplankton species composition, density and biomass of in situ and preserved samples. The work addresses four hypotheses: 1) Phytoplankton and zooplankton species vary at high frequency spatial scales in relation to each other and to water quality variables along the longitudinal axis of the estuary such that they form patches with different abiotic and biotic characteristics; 2) Phytoplankton and zooplankton community composition vary at high frequency (e.g., hourly to weekly) temporal scales in relation to each other and to water quality variables; 3) The FlowCAM® is a more reliable and better indicator of in situ phytoplankton community composition and biomass than the FluoroProbe which measures phytoplankton pigment concentration; 4) The FlowCAM® is an accurate, reliable and more rapid method for identification, enumeration and biomass estimates of phytoplankton and zooplankton species than microscopy for preserved samples. The project relates to PSP Topics 4, 2 and 3 and addresses CALFED and IEP goals to develop monitoring programs in order to adaptively manage critical habitat for fishery production and restoration. Deliverables include progress and final reports, two journal articles, a technical manual for FlowCAM® sampling in the delta, a digital image library of species and presentations at CALFED, national and local meetings. The project is a collaboration between Dr. Lehman and Dr. MuellerSolger at the CA Department of Water Resources, experts in phytoplankton, zooplankton and water quality in the delta, and Dr. Poulet at Bigelow Laboratory for Ocean Sciences and Fluid Imaging Technologies Inc., an expert in the use of the FlowCAM® to quantify plankton. Student assistants will be provided by Dr. Dahlgren at U.C. Davis.