Executive Summary

In this research proposal, we describe work to develop and evaluate an integrated system for the prediction of Delta flows and transport in real-time that doesn't rely upon historical data sets for calibration and validation. The system consists of observational and computational components, along with real-time communication and coordination. The over-arching goal of the work is to allow for the prediction of Delta flows and transport at the timescale of days to weeks, even when there has been major changes to the Delta geometry (such as levee breaches).

The observational component of the work consists of a network of Lagrangian drifters that communicate to a base station in real-time to establish the instantaneous velocity field. The advantages of Lagrangian measurements are: (1) drifters can be rapidly and easily deployed in locations of interest, such as the position of outmigrating salmon, or adjacent to levee breaches; and (2) the Lagrangian velocity field is the important measure of net transport in a highly dispersive channel system like the Delta, where subtle phase differences between the various channels dominate the net transport and dispersion.

Computationally, we propose to develop an inverse approach to predicting Delta flows that does not rely on the specification of boundary conditions a priori, but rather estimates the necessary forcing based on observations in the interior of the domain. Our intention is to apply this method to Delta subregions in order to establish the net transport in particular locations of interest in the Delta. For most inverse modeling methods, flows would only be reasonably estimated during the period of observation, which would severely limit the applicability of the approach for management and operational decision making. Our formulation of the open boundary conditions, however, takes advantage of the tidal dominance in the forcing and the inverse estimation of the boundary conditions focuses on defining the amplitude and phase of the important tidal harmonics. Combining these tidal parameters with a linear trend in the boundary conditions allows us to project both the boundary conditions and the resulting flows ahead of the observational period, perhaps to as long as several weeks or a month. The development of the inverse modeling approach will be based on two existing data sets: one collected in the vicinity of Mildred Island in September 2001, one collected at the intersection of the Sacramento River and Georgiana Slough in May 2004.

Finally, we propose an integrated experiment that incorporates both the drifter network and the inverse model calculations. We will choose a domain for this experiment that has existing instrumentation, given the current set of UVMs, we propose an experiment in the South Delta along Old and Middle Rivers, but we may adjust the location depending on other instrumentation in the Delta. This experiment will involve real-time data collection by the drifters, communication of that data with the base station, and the inverse estimation of boundary conditions leading to a projection forwards in time of flows in the local channels. Our goal here is to test the accuracy and reliability of a real-time, calibration-free approach to Delta flows, including a critical evaluation of the trade-offs between the veracity of our flow the predictions and observational or computational expense. Finally, we will compare our ability to predict.