Modeling the Delta Smelt Population of the San Francisco Estuary

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The threatened delta smelt is arguably the most important species for management and restoration in the San Francisco Estuary. Singularly dependent on the Sacramento-San Joaquin Delta and Suisun Bay, delta smelt is highly vulnerable to entrainment in export pumping facilities. The management attention to this fish has led to some important advances in our understanding of its population dynamics, and to improvements in how this species is monitored. However, we lack population models necessary to extend and test the scope of our present knowledge, and to quantitatively explore management alternatives. It is therefore timely to develop and apply computer models to the delta smelt population. Such models can be useful in organizing the available information and placing it in a population context, pointing out key information gaps, and investigating the implications of alternative management strategies.

*The proposed project will develop, test, and apply three classes of computer models for delta smelt: **particle-tracking models**, an **individual-based model**, and **matrix projection models**.* These models have very different spatial and temporal scales, and different objectives. Particle-tracking models (PTMs) are useful for exploring short-term transport and movement over fine-scale spatial variability. PTMs are especially useful in the Sacramento-San Joaquin Delta where a major concern is the transport towards and entrainment of delta smelt in the south Delta water export facilities. Individual-based models (IBMs) focus on life-history characteristics of individual fish, building the population response from the summed interactions of the individuals. IBMs require substantial knowledge of the physiology and behavior of the species and are most useful for exploring the population responses to complex combinations of alternative environmental (e.g., food, water temperature) and management scenarios. Matrix projection models take a more broad-brush approach to modeling population dynamics by lumping individuals into age or stage groups and following the numbers in each stage, rather than individuals. The mathematics and analysis of matrix projection models is well developed. Matrix projection models also allow for the easy investigation of hypotheses, quick mathematical analysis of population responses, and determination of the relative importance of various life stages and population processes (e.g., fecundity, survival) to the predicted responses.

These three types of models will be developed in a collaborative arrangement among San Francisco State University, the University of California at Davis, Stanford University, and Louisiana State University. The PTM will be applied at Stanford University by Monismith and colleagues. The IBM will be developed based upon a preliminary IBM assembled for the 2003 EWA delta smelt workshop, which in turn is based on previous modeling work by Rose and colleagues. As part of this proposed project, we will hire a postdoctoral research associate to do most of the coding, testing, and analysis under Kimmerer's supervision, with advice and assistance from Rose and Bennett. The matrix projection models will be developed by Bennett and a Ph.D. student, with advice and assistance from Rose and Kimmerer.

Feasibility of such an ambitious project as the one proposed here depends on the capabilities of the scientists involved, as well as on the organization of the project. The investigators on this project have many years of experience individually, each of the investigators has worked extensively with at least one of the other investigators, and the responsibilities and interactions specifically for this proposed project are clearly laid out in this proposal. Development of all three model types will also take advantage of the collective knowledge of the community of scientists in the region, through workshops and presentations as well as personal contact.