EFFECTS OF FISH SCREEN EXPOSURE ON

THREATENED DELTA SMELT

BEHAVIOR AND SURVIVAL

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In California's Sacramento-San Joaquin estuary, delta smelt *(Hypomesus transpacificus*) are exposed to thousands of water diversions located within their habitat. Entrainment losses at these diversions, most of which are unscreened, are thought to have contributed to the decline of this species and its resultant listing under the federal Endangered Species Act as threatened in 1993. However, limited information on delta smelt physiological and behavioral responses to artificial flows like those near diversions or to positive barrier fish screens has prevented development of effective fish screen designs or operational criteria for this species. In particular, planned renovations of the large state and federal water project facilities that are located along the delta smelt's migratory path require improved understanding of the responses and capabilities of this delicate fish.

To provide the information needed to develop fish screen criteria for delta smelt, we evaluated the performance and behavior of the fish near a simulated fish screen using the Fish Treadmill. This apparatus, a large annular flume equipped with a fish screen (2.3-mm vertical wedgewire, 50% porosity), is capable of producing two-vector flow regimes (i.e., approach flow, perpendicular to the

screen, and sweeping flow, parallel to the screen) similar to those near screened water diversions. For groups of 20 fish (12□C, 4-8 cm SL) exposed for 2 hours to combinations of approach (range: 0-15 cm/s) and sweeping flows (range: 0-62 cm/s) during the day (lighted conditions) and night (dark conditions), we measured fish-screen contact frequency, impingement rates, stress, injury rates and severity, survival, and screen passage velocity.

For subadult and adult delta smelt, fish-screen contact rates, impingement rates, plasma cortisol, and 48-h post-exposure mortality rates all increased with increases in both approach and sweeping velocities. Injury rates were directly related to screen contact rates and strongly correlated with mortality; at high velocity flow combinations, mortality rates >50% were not uncommon. On the other hand, screen passage velocities were directly related to sweeping velocities, with the fish generally being swept downstream at flows >31 cm/s. General linear statistical models developed from these results provide guidance for developing several specific aspects of fish screen flow and operational criteria; for example, flow regimes that maximize survival from appropriate screen exposure durations and fish screen lengths. Applications of these results and models to fish screen design and operation will improve delta smelt protection during and after exposure to a screened water diversion.

This research is supported by California Department of Fish and Game, California Department of Water Resources, U.S. Bureau of Reclamation, CALFED Bay Delta Program, and the Anadromous Fish Screen Program (U.S. Fish and Wildlife Service and U.S. Bureau of Reclamation). We also thank the UC Davis Hydraulics Laboratory, Department of Civil and Environmental Engineering, for their design, construction, and operation of the Fish Treadmill; the California Department of Fish and Game, for their assistance collecting delta smelt and conducting the experiments; and our student, post-graduate, and post-doctoral research assistants from the University of California, Davis, Department of Wildlife, Fish, and Conservation Biology, M. Danley, N. West, S. Chun, T. Chen, M. Kondratieff, T. MacColl, T. Reid, S. Katzman, D. Shigematsu, J. Cervantes, J. Hsu, S. Lema, K. Day, C. Meloni, S. Gough, M. Karagosian, R. Mayfield, B. Nathaniel, M. Gonzalez, C. Lee, L. Hatton, M. Lee, S. Carlson, C. Peregrin, D. Warren, B. Begun, M. Kuoppamaki, A. Pickersgill, J. Heublein, A. Robb, M. Schoessler, T. Mussen, C. O'Grady, B. Ransom, S. Marquis, E. Zhu, F. Mo, A. Lochner, K. Tran, P. Lin, S. Somers, B. Ta, J. Roessig, without whom this work would not be possible.