

Hierarchical modeling of out-migrating juvenile salmon survival in an estuary network using release-recovery data

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The abundance of salmon native to central California has declined precipitously relative to numbers present at the beginning of the 1900s, with two of the runs on the federal endangered species list. For over 30 years the US Fish and Wildlife Service have been carrying out release-recovery studies to attempt to understand the freshwater factors that most influence survival. The studies include tagging and releasing juvenile salmon into the San Joaquin River and the California Delta, at multiple locations, during their out-migration period and then later recovering the fish with trawling gear at one or two downstream sites. Previous analyses of these data have been piecemeal and *ad hoc*, e.g., regressing recovery fractions at a single location from a single release location against environmental covariates with sampling error and environmental variation ignored. A hierarchical modeling approach is proposed which uses all the release-recovery data in a structured coherent fashion, accounts for multiple sources of uncertainty, and models reach-specific survival probabilities as a function of environmental covariates.