Supporting Decisions through Collaborative Science: How CSAMP Works

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The Collaborative Science and Adaptive Management Program (CSAMP) is an applied science program specifically designed to inform decisions regarding water project operations and species protection in the Delta. The Program was established in 2013 as an outgrowth of litigation and is intended to provide an alternative where parties can work together to address critical uncertainties and promote common understanding. The Program is explicitly structured to integrate science and decision making through early and active engagement of decision makers in the formulation of key management questions. Management questions are then used in an adaptive management framework to drive the development of studies and tools which can improve our understanding and inform future decisions. The Program represents a unique engagement of decision makers, managers, and scientists from state and federal resource agencies, environmental organizations, and public water agencies working together to solve difficult, contentious management issues in the Delta. By providing an overview of the Program, this presentation will set the stage for the four other presentations in the special session which will describe specific CSAMP science investigations.

Keywords: Integrated Science and Decision Making, Adaptive Management, Species Protection
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Collaborative Adaptive Management Team (CAMT) Investigations: Using New Modeling Approaches to Understand Delta Smelt State Salvage Patterns at the State Water Project and Central Valley Project

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As part of the Collaborative Adaptive Management Team (CAMT) investigations, we examined historical (1993-2015) salvage data to determine what factors affected Delta Smelt salvage at the State Water Project (SWP) and Central Valley Project (CVP) fish facilities. Our objective was to determine if new approaches could be applied to the data to yield new insights about the factors that explain Delta Smelt salvage patterns within and across years. Generalized additive models (GAMs) and Boosted Regression Trees (BRTs) were applied to a suite of predicator variables at different time scales of management relevance. Model performance was compared using cross-validation metrics. Overall, our preliminary models explained up to 78 % of the annual variability in Delta Smelt salvage. Combined exports, turbidity, FMWT index, and net delta outflow variables were retained in most models as the best explanatory variables. Results from this study improve upon previous analyses of salvage data and provide a framework for understanding factors that best explain entrainment risk conditions. In conjunction with our other CAMT studies, this work can be used by management to develop actions to protect Delta Smelt during high risk scenarios when they are most vulnerable to entrainment.

Keywords: Delta smelt, salvage, adaptive management, entrainment
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Evaluating Potential Swimming Behaviors of Adult Delta Smelt by Application of a Particle-Tracking Model with Alternative Behavior Rules

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Multiple individual based models of delta smelt have been developed, with the long-term goal of providing a tool for evaluating entrainment risk in a real-time environment. Each model consists of a set of simple behavior rules indicating delta smelt swimming responses to environmental stimuli and a particle-tracking model. Environmental stimuli considered include current speed and direction, salinity, turbidity, water depth, and distance to shore. Particle-tracking methods are applied to estimate the paths of delta smelt for combined hydrodynamic velocity and swimming. Both a depth-averaged model (RMA2) and a three-dimensional model (UnTRIM) were applied to supply hydrodynamic velocity and other environmental conditions. Qualitative and quantitative comparisons of predicted and observed delta smelt distribution are performed with the goal of identifying one or more plausible behaviors that merit further study. The observations used in this study include Spring Kodiak Trawl observations and salvage for 2002 and other years and the observations of Bennett and Burau (2014) in December 2010 to January 2011. For the Spring Kodiak Trawl periods simulated, the predictions of movement for different hypothesized behaviors and the catch observations are compared in a fitting approach which has initial abundance, natural mortality and salvage efficiency as free parameters. In the Bennett and Burau observation period a more qualitative approach is applied in which initial distribution is assumed and subsequent distribution is predicted over the following weeks for several behaviors without accounting for mortality. Simple representations of some previously hypothesized behaviors lead to predicted distribution broadly inconsistent with observed distributions. Slightly more complex behaviors involving both turbidity triggers and some form of tidal migration provide predictions more consistent with observed distributions.

Keywords: delta smelt, particle tracking, hydrodynamic model, UnTRIM, RMA2
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Effects of Water Project Operations on Juvenile Salmon Survival in the Delta: Literature and Data Review

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The effects of water project operations (WPO) on survival of juvenile salmon migrating through the Delta is of high concern to managers. We performed a literature review on the survival effects of WPO, including exports (E), Delta inflow (I), the San Joaquin River (SJR) I:E ratio, and the Delta E:I ratio. We also compiled estimates of through-Delta survival from CWT and acoustic-telemetry (AT) studies of SJR fall-run Chinook salmon, and reach-specific survival estimates from AT studies, and compared them to measures of Delta inflow, exports, and I:E. Through-Delta survival of SJR Chinook has been low (<0.20) since 2002 regardless of flow and exports operations. Sacramento River (SR) Chinook survival has varied more, with 2014 estimates ranging from 0.00 to 0.30 for spring- and fall-run Chinook, and up to 0.35 for winter-run Chinook. The Head of Old River Barrier (HORB) is effective at diverting SJR fish away from the interior Delta, but consistently low survival in all routes limits its protective effect on through-Delta survival. For SJR Chinook, higher SJR flow is associated with higher survival particularly when the HORB is in place, and the flow effect is strongest in the upstream reaches; very low through-Delta survival has been observed even in high flow years or with the HORB in place. Evidence of an export effect on through-Delta survival was both weak and inconsistent for SJR Chinook. The relationship between Delta survival of SJR Chinook and I:E is variable but generally positive for lower I:E values (e.g., I:E < 3); statistical analysis suggests a weak but generally negative effect of increased Delta E:I on survival of SR Chinook. Large uncertainties remain in how WPO influences salmon survival in the Delta and in population-level effects, which will require cooperation between resource management/funding agencies and researchers to resolve.

Keywords: Chinook salmon, Delta, exports, inflow, barrier, water project operations
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CAMT Salmonid Scoping Team – Recommendations for Future Salmonid Investigations

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Problem: Survival through the Sacramento-San Joaquin River Delta (Delta) has been low for San Joaquin River Chinook salmon, averaging approximately 5% since 2002, and variable for Sacramento River Chinook salmon; survival data are limited for steelhead. Water export operations contribute to salmonid mortality via direct mortality at facilities, but direct mortality does not account for the majority of Delta mortality; the contribution of various stressors to the high mortality is unknown.

Approach: A collaborative process involving technical experts participating on the CAMT Salmonid Scoping Team (SST) was initiated in 2013. The SST synthesized technical information regarding hydrodynamics, juvenile salmonid migration, and survival in the Delta related to operations of the State Water Project and Central Valley Project. In June 2016 the SST issued reports to CAMT that reviewed the available information, identified gaps in existing knowledge, provided recommendations for future actions, and addressed eight specific management questions.

Results: The SST provided CAMT with the following recommendations:

- Expand the analysis of existing survival data to address information gaps, management issues, and testable hypotheses as part of developing a long-term survival program
- Implement short-term actions to improve salvage facility operations
- Develop a long-term monitoring, research and adaptive management plan
- Implement the long-term monitoring, research and adaptive management plan

Conclusions/Relevance: Implementation of the long-term monitoring, research and adaptive management plan will allow water project operations to be assessed. It will reduce uncertainty, potentially identify the incremental role water projects operations have on salmonid survival through the Delta, and potentially lead to adjustments to water project operations that improve survival beyond current levels. Information developed through implementing the plan could be integrated with, and incorporated into, decision support tools used to better manage the system. The long-term plan could be integrated with other major monitoring programs in the Central Valley.

Keywords: Salmonid survival, Delta collaborative, adaptive management, water export operations
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