Draft Outline of a Scope of Work for
Assessing Population Effects of Entrainment
Workplan Element 3-2-2
(to address CAMT Progress Report 2/7/14, Table 3-2, Element 2)

Note: Comments from Scoping Team members have purposefully be left in this document to provide additional context for investigators and reviewers regarding the discussion of entrainment. Text shown in italics is taken directly from the Table 3-2 of the CAMT Progress Report (February 2014).

Work Element 3-1-3: *Assessing Population Effects* of Entrainment.

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Key Question: *What are the effects of entrainment* of delta smelt *on the population?*

a. *What is the magnitude (e.g. % of population) of adult and larval entrainment across different years and environmental conditions?*
b. *How do different levels of entrainment for adults and larvae affect population dynamics, abundance, and viability? (*Are delta smelt entrained at Project facilities at levels that are likely to affect the size and potential for recovery of the population in the Estuary?)
c. Does the proportion of adult delta smelt in the south Delta, derived from the Spring Kodiak Trawl, provide a more reliable estimate of the proportion of the adults entrained than estimates derived from salvage and population estimates?
d. Has the historic carrying capacity (survival rate of delta smelt within certain years) been limited by availability of scarce resources, such as food?

Comment [SAH1]: This question was prompted by a concern that estimates of proportional entrainment based on salvage and population estimates might have very large error bars and require multiple assumptions many of which cannot be verified. Are their better was of estimating proportional entrainment perhaps based on SKT data. Would sampling need to be enhanced for the SKT to provide a reliable estimate?

Comment [SAH2]: I was wondering if resource limitations through the year may have "density dependency" type consequences even though populations of smelt are low. That is, the proportion of smelt surviving to the next life stage might be lower than "normal" for some life stages in some years because of a resource constraint. If so, this would suggest that the population consequences of events prior to the constraint event may be less than expected and that our focus should perhaps shift to identifying and removing the resources constraint.

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Relevance/Rationale:	*Understanding the proportion of fish lost to entrainment is a key issue in the determination of incidental take levels, but a broader question is the degree to which entrainment affects Delta Smelt population dynamics and viability. This insight is needed to better describe when Delta Smelt entrainment levels are at a low or high risk to the population.*
Possible Investigative Approach:	Several possible approaches exist to assess the proportion of the population entrained: *1) population estimates; 2) relative measures and* 3) estimates derived from models. *The first approach requires estimates of both entrainment losses and the population size of Delta Smelt. A second approach* considers *densities of fish collected at*, or near, *the export facilities can be compared with densities at multiple locations across the distribution of the species*. A third approach, the *application of different models (e.g. IBM, life history),* could *be explored as a means to estimate proportional entrainment.* Review existing studies, considering the strength, weaknesses and relevance of such work.
Investigative Challenges:	*The relationship between salvage and entrainment is poorly understood and likely variable, making it difficult to get accurate estimates of entrainment (Kimmerer 2011; Miller 2011; Castillo et al. 2012). Key information is lacking to develop reliable population estimates for Delta Smelt (Newman 2008*). A *major challenge is that Delta Smelt catch in fish surveys has been very low since the onset of the Pelagic Organism Decline in 2002 (Sommer et al. 2007). The present low detection probability means that uncertainty is high about both entrainment and relative population levels.*
Methods:	To be determined by investigators. Possibly includes: a list specific hypotheses to be tested; identification and specification of covariates, relevant data sets, and modeling and statistical methods. Resources available to investigators: IEP survey data including catch per unit effort and abiotic data, Larval survey data, Synthetic turbidity data, Bathymetry and water volume data,

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Velocity data,
Phytoplankton survey data,
Zooplankton survey data,
Data from continuous water quality recorders at a limited number of locations;
Salvage data,
GIS services,
Informal discussion or review with scoping group members and advisors.

Example Draft Hypotheses:

a. Delta Smelt are entrained at Project facilities at levels that are likely to affect the long-term abundance and potential for recovery of the Delta Smelt population

b. The proportion of adult delta smelt in the south Delta, derived from the Spring Kodiak Trawl, provide a more reliable estimate of the proportion entrained than estimates derived from salvage and population estimates

c. The survival rate of delta smelt within certain years has been limited by availability of certain necessary resources.

Applications of Findings To Management: *The proportional entrainment of Delta Smelt is a major management issue for the establishment of take limits in the Delta Smelt Biological Opinion (FWS 2008).*

Technology Transfer: Investigators should be prepared to provide a written report, manuscript, and a presentation of findings to CSAMP. Investigators should provide data sets, including covariates utilized in analyses, and any model that have been developed, to the scoping group at the completion of the study.

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RELEVANT RESOURCES

1. Castillo, G., Morinaka, J., Lindberg, J., Fujimura, R., Baskerville-Bridges, B., Hobbs, J., Tigan, G., Ellison, L., (2012) Pre-screen loss and fish facility efficiency for delta smelt at the south delta's State Water Project, California. San Francisco Estuary and Watershed Science. 10:1-23.

2. Culberson, S.D., Harrison, C.B., Enright, C., and Nobriga, M.L., (2004) Sensitivity of Larval Fish Transport to Location, Timing, and Behavior Using a Particle Tracking Model in Suisun Marsh, California. American Fisheries Society Symposium 39:257–267.

3. Kimmerer, W.J. 2008. Losses of Sacramento River Chinook salmon and delta smelt to entrainment in water diversions in the Sacramento San Joaquin Delta. San Francisco Estuary and Water shed Science. Vol. 6, Issue 2, Article 2.

4. Kimmerer, W.J. Modeling Delta Smelt Losses at the South Delta Export Facilities. San Francisco Estuary and Watershed Science, 9(1). 2011.http://escholarship.org/uc/item/0rd2n5vb

5. Miller, William J. (2011). Revisiting Assumptions that Underlie Estimates of Proportional Entrainment of Delta Smelt by State and Federal Water Diversions from the Sacramento San Joaquin Delta. San Francisco Estuary and Watershed Science, 9(1).

6. Moyle, P.B., and Israel, J.A., (2005) Untested assumptions: effectiveness of screening diversions for conservation of fish populations. Fisheries 30(5):20-28.

7. Brown, L.R., Kimmerer, W. and Brown, R. (2009) Managing Water to Protect Fish: A review of California's Environmental Water Account, 2001-2005. Environmental Management, Vol. 43, No. 2, Pgs. 357-368.

8. MacNally, R., J. R. Thomson, W. J. Kimmerer, F. Feyrer, K. B. Newman, A. Sih, W. A. Bennett, L. Brown, E. Fleishman, S. D. Culberson, and G. Castillo. Analysis of pelagic species decline in the upper San Francisco Estuary using multivariate autoregressive modeling (MAR). *Ecol. Appl.* 20: (1417–1430) (2009).

9. Maunder MN, Deriso RB. 2011. A state–space multistage life cycle model to evaluate population impacts in the presence of density dependence: illustrated with application to delta smelt (Hyposmesus transpacificus). Canadian Journal of Fisheries and Aquatic Sciences 68(7):1285-1306.

10. Thomson, J. R, W. J. Kimmerer, L. Brown, K. B. Newman, R. Mac Nally, W. A. Bennett, F. Feyrer, and E. Fleishman. Bayesian change-point analysis of abundance trends for pelagic fishes in the upper San Francisco estuary. *Ecol. Appl.* 20: (1431–1448) (2009).

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11. Kenneth A. Rose, Wim J. Kimmerer, Karen P. Edwards, William A. Bennett. Individual-Based Modeling of Delta Smelt Population Dynamics in the Upper San Francisco Estuary: I. Model Description and Baseline Results and II. Alternative Baselines and Good versus Bad Years, Transactions of the American Fisheries Society 142:1238–1259 and 1260–1272, respectively, 2013.

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