

**Recommended Key Literature for the State Water Board's Deliberations re:  
Delta Outflow Standards for the Water Quality Control Plan Update**

Below, we identify some of the most important studies and syntheses that the Science Panel and State Water Board should rely on in making recommendations and decisions on Delta Outflow requirements. Many of these papers are included in the reading list provided to the Science Panel – additional studies, NOT included in the materials given to the Science Panel are underlined and are attached.

**“Charge to the Panel**

*The Panel is charged with reviewing and assessing the provided written materials and oral presentations in order to identify the best available science to inform the State Water Board's decisions on Bay-Delta Plan requirements related to Delta outflow and related factors (Delta outflow requirements). The Panel will evaluate and synthesize the best available scientific information and prepare a report that addresses the following questions:*

*1. What are the key studies and synthesis reports that the State Water Board should rely on in making their decisions on Delta outflow requirements? Please comment on the strength and relevance of the science presented and reviewed.”*

See specific recommendations to address each question below. In general:

Cloern, J.E. and A.D. Jassby. 2012. Drivers of change in estuarine-coastal ecosystems: Discoveries from four decades of study in San Francisco Bay. *Reviews of Geophysics* 50, RG4001, doi:10.1029/2012RG000397.

NRC. 2010. A Scientific Assessment of Alternatives for Reducing Water Management Effects on Threatened and Endangered Fishes in California's Bay Delta.

NRC. 2012. Sustainable Water and Environmental Management in the California Bay-Delta.

SWRCB. 2010. Development of Flow Criteria for the Sacramento-San Joaquin Delta Ecosystem. [http://www.waterboards.ca.gov/waterrights/water\\_issues/programs/bay\\_delta/deltaflow/docs/final\\_rpt080310.pdf](http://www.waterboards.ca.gov/waterrights/water_issues/programs/bay_delta/deltaflow/docs/final_rpt080310.pdf)

**“2. The existing Delta outflow objectives are based largely on documented relationships between a suite of estuarine organisms and the 2 ppt isohaline (X2).**

- **Should these flow relationships still be used as the basis for protecting estuarine fish, estuarine fish habitat, and other important ecosystem attributes?**
- **Are there other methods or indicators available to serve as the basis for protecting estuarine fish, estuarine fish habitat, and other important ecosystem attributes? If so, what are they and how could they be applied?”**

- Feyrer, F., M.L. Nobriga, and T.R. Sommer. 2007. Multi-decadal trends for three declining fish species: habitat patterns and mechanisms in the San Francisco Estuary, California, USA. *Canadian Journal of Fisheries and Aquatic Sciences* 64(4):723-734.
- Hobbs, J.A., W.A. Bennett, and J.E. Burton. 2006. Assessing nursery habitat quality for native smelts (*Osmeridae*) in the low-salinity zone of the San Francisco Estuary. *Journal of Fish Biology* 69:907-922.
- Jassby, A.D., W.J. Kimmerer, S.G. Monismith, C. Armor, J.E. Cloern, T.M. Powell, J.R. Schubel, and T.J. Vendlinski. 1995. Isohaline position as a habitat indicator for estuarine applications. *Ecological Applications* 5(1):272-289.
- Kimmerer, W.J. 2002. Effects of freshwater flow on abundance of estuarine organisms: physical effects or trophic linkages? *Marine Ecology and Progress Series* 243:39-55.
- Kimmerer, W. 2004. Open Water Processes of the San Francisco Estuary: From Physical Forcing to Biological Responses. *San Francisco Estuary and Watershed Science* 2(1):1. <http://escholarship.org/uc/item/9bp499mv>
- Kimmerer, W.J., E.S. Gross, and M.L. MacWilliams. 2009. Is the response of estuarine nekton to freshwater flow in the San Francisco Estuary explained by variation in habitat volume? *Estuaries and Coasts* 32:375-389.
- Mac Nally, R., J.R. Thomson, W.J. Kimmerer, F. Feyrer, K.B. Newman, A. Sih, W.A. Bennett, L. Brown, E. Fleishman, S.D. Culbertson, and G. Castillo. 2010. An analysis of pelagic species decline in the upper San Francisco Estuary using multivariate autoregressive modeling. *Ecological Applications* 20(5):1417-1430.
- Monismith, S.G., W.J. Kimmerer, J.R. Burau, and M.T. Stacey. 2002. Structure and flow-induced variability of the subtidal salinity field in northern San Francisco Bay. *Journal of Physical Oceanography* 32:3003-3019.
- Nobriga, M., T. Sommer, F. Feyrer, and K. Fleming. 2008. Long-term trends in summertime habitat suitability for delta smelt, *Hypomesus transpacificus*. *San Francisco Estuary and Watershed Science* 6(1):1. <http://escholarship.org/uc/item/5xd3q8tx>.
- Thomson, J.R., W.J. Kimmerer, L.R. Brown, K.B. Newman, R. Mac Nally, W.A. Bennett, F. Feyrer, and E. Fleishman. 2010. Bayesian change point analysis of abundance trends for

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pelagic fishes in the upper San Francisco Estuary. *Ecological Applications* 20(5):1431-1448.

SWRCB. 2010. Development of Flow Criteria for the Sacramento-San Joaquin Delta Ecosystem. [http://www.waterboards.ca.gov/waterrights/water\\_issues/programs/bay\\_delta/deltaflow/docs/final\\_rpt080310.pdf](http://www.waterboards.ca.gov/waterrights/water_issues/programs/bay_delta/deltaflow/docs/final_rpt080310.pdf)

The Bay Institute. 2010. Written Testimony of Jonathan Rosenfield, Ph.D., Conservation Biologist, The Bay Institute, Christina Swanson, Ph.D., Executive Director and Chief Scientist, The Bay Institute. Regarding Flow Criteria for the Delta Necessary to Protect Public Trust Resources: Delta Outflows. February 16, 2010.

***“3. What scales (magnitude and duration) of outflow change are needed to produce measurable changes in native species population viability and/or ecosystem function over what time frame? Are there thresholds for achieving specific responses?”***

SWRCB. 2010. Development of Flow Criteria for the Sacramento-San Joaquin Delta Ecosystem. [http://www.waterboards.ca.gov/waterrights/water\\_issues/programs/bay\\_delta/deltaflow/docs/final\\_rpt080310.pdf](http://www.waterboards.ca.gov/waterrights/water_issues/programs/bay_delta/deltaflow/docs/final_rpt080310.pdf)

The Bay Institute. 2010. Written Testimony of Jonathan Rosenfield, Ph.D., Conservation Biologist, The Bay Institute, Christina Swanson, Ph.D., Executive Director and Chief Scientist, The Bay Institute. Regarding Flow Criteria for the Delta Necessary to Protect Public Trust Resources: Delta Outflows. February 16, 2010.

**“4. How are other factors that affect estuarine fish, estuarine fish habitat, and other ecosystem attributes likely to interact with Delta outflow requirements?”**

- **Are there tools or methods available that could help the State Water Board to better assess the interactions between flow and other factors that affect the estuarine fish, estuarine fish habitat, and other important ecosystem attributes?**
- **Can we reasonably expect that addressing other stressors without addressing flow will lead to specific improvements in the status of estuarine fish, estuarine fish habitat, and other important ecosystem attributes?**
- **Conversely, can we reasonably expect that addressing flow without addressing other stressors will lead to specific improvements in the status of estuarine fish, estuarine fish habitat, and other important ecosystem attributes?”**

Dugdale, R.C., F.P. Wilkerson, V.E. Hogue, and A. Marchi. 2007. The role of ammonium and nitrate in spring bloom development in San Francisco Bay. *Estuarine, Coastal and Shelf Science* 73(1-2):17-29.

Dugdale, R., F. Wilkerson, A.E. Parker, A. Marchi, and K. Taberski. 2012. River flow and ammonium discharge determine spring phytoplankton blooms in an urbanized Estuary. *Estuarine, Coastal and Shelf Science*, 115:187-199.

Cloern, J.E. and A.D. Jassby. 2012. Drivers of change in estuarine-coastal ecosystems: Discoveries from four decades of study in San Francisco Bay. *Reviews of Geophysics* 50, RG4001, doi:10.1029/2012RG000397.

Jassby, A.D. 2008. Phytoplankton in the Upper San Francisco Estuary: recent biomass trends, their causes and their trophic significance. *San Francisco Estuary and Watershed Science* 6(1):2. <http://escholarship.org/uc/item/71h077r1>.

Herbold, B; D.M. Baltz, L. Brown, R. Grossinger, W. Kimmerer, P. Lehman, P.B. Moyle, M. Nobriga, C.A. Simenstad, C. Wilcox. in press. The Role of Tidal Marsh Restoration in Fish Management in the San Francisco Estuary. *San Francisco Estuary and Watershed Science*.

Kuivila, K.M. and Hladik, M.L. 2008. Understanding the occurrence and transport of current-use pesticides in the San Francisco Estuary Watershed. *San Francisco Estuary and Watershed Science* 6(3):2. <http://repositories.cdlib.org/jmie/sfews/vol6/iss3/art2>.

Lucas, L.V., J.K. Thompson, and L.R. Brown. 2009. Why are diverse relationships observed between phytoplankton biomass and transport time? *Limnology and Oceanography*, 54(1): 381–390.

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- Matern, S.A., P.B. Moyle, and L.C. Pierce. 2002. Native and alien fishes in a California estuarine marsh: twenty-one years of changing assemblages. *Transactions of the American Fisheries Society*, 131:797-816.
- Rose , K. A. W.J. Kimmerer , K.P. Edwards & William A. Bennett (2013a) Individual-Based Modeling of Delta Smelt Population Dynamics in the Upper San Francisco Estuary: I. Model Description and Baseline Results, Transactions of the American Fisheries Society, 142:5, 1238-1259
- Rose , K.A., Wim J. Kimmerer , Karen P. Edwards & William A. Bennett (2013b) Individual-Based Modeling of Delta Smelt Population Dynamics in the Upper San Francisco Estuary: II. Alternative Baselines and Good versus Bad Years, Transactions of the American Fisheries Society, 142:5, 1260-1272  
<http://dx.doi.org/10.1080/00028487.2013.799519>
- Rosenfield, J.A. 2010. Life History Conceptual Model and Sub-Models for Longfin Smelt, San Francisco Estuary Population. Delta Regional Ecosystem Restoration Implementation Plan. <https://nrm.dfg.ca.gov/FileHandler.ashx?DocumentID=28421>.
- Schoellhamer, D.H. 2001. Influence of salinity, bottom topography, and tides on locations of estuarine turbidity maxima in northern San Francisco Bay, in McNally, W.H. and Mehta, A.J., ed., *Coastal and Estuarine Fine Sediment Processes*. Elsevier, Amsterdam, The Netherlands.
- The Bay Institute. 2010. Written Testimony of Jonathan Rosenfield, Ph.D., Conservation Biologist, The Bay Institute, Christina Swanson, Ph.D., Executive Director and Chief Scientist, The Bay Institute. Regarding Flow Criteria for the Delta Necessary to Protect Public Trust Resources: Delta Outflows. February 16, 2010.
- SWRCB. 2010. Development of Flow Criteria for the Sacramento-San Joaquin Delta Ecosystem. [http://www.waterboards.ca.gov/waterrights/water\\_issues/programs/bay\\_delta/deltaflow/docs/final\\_rpt080310.pdf](http://www.waterboards.ca.gov/waterrights/water_issues/programs/bay_delta/deltaflow/docs/final_rpt080310.pdf)
- Winder, M. and A.D. Jassby. 2011. Shifts in zooplankton community structure: implications for food web processes in the upper San Francisco Estuary. *Estuaries and Coasts* 34:675-690.

***“5. How should Delta outflow be measured and managed to better reflect the flows necessary to protect estuarine fish, estuarine fish habitat, and other important ecosystem attributes?***

- To what extent does managing winter-spring outflow by X2 reflect the flows necessary to protect estuarine fish? Are there other approaches to managing winter-spring outflow that could improve our ability to protect estuarine fish, estuarine fish habitat, and other important ecosystem attributes?***
- How should summer-fall outflow be measured and managed to better reflect the flows necessary to protect estuarine fish, estuarine fish habitat, and other important ecosystem attributes? Are there other approaches to managing summer-fall outflow that could improve our ability to protect estuarine fish, estuarine fish habitat, and other important ecosystem attributes?”***

Cloern, J.E. and A.D. Jassby. 2012. Drivers of change in estuarine-coastal ecosystems: Discoveries from four decades of study in San Francisco Bay. *Reviews of Geophysics* 50, RG4001, doi:10.1029/2012RG000397.

Enright, C. and S.D. Culberson. 2009. Salinity trends, variability, and control in the northern reach of the San Francisco Estuary. *San Francisco Estuary and Watershed Science* 7(2):3. <http://escholarship.org/uc/item/0d52737t>.

Richter, B.D. M.M. Davis, C. Apse, and C. Konrad. 2011. A presumptive standard for environmental flow protection. *River and Research Applications*. *River Research and Applications*. DOI: 10.1002/rra.1511

The Bay Institute. 2010. Written Testimony of Jonathan Rosenfield, Ph.D., Conservation Biologist, The Bay Institute, Christina Swanson, Ph.D., Executive Director and Chief Scientist, The Bay Institute. Regarding Flow Criteria for the Delta Necessary to Protect Public Trust Resources: Delta Outflows. February 16, 2010.

SWRCB. 2010. Development of Flow Criteria for the Sacramento-San Joaquin Delta Ecosystem. [http://www.waterboards.ca.gov/waterrights/water\\_issues/programs/bay\\_delta/deltaflow/docs/final\\_rpt080310.pdf](http://www.waterboards.ca.gov/waterrights/water_issues/programs/bay_delta/deltaflow/docs/final_rpt080310.pdf)