Public Workshop (9/5-6/12)
Bay-Delta Workshop 1
Deadline: 8/17/12 by 12 noon

Workshop 1 – Ecosystem Changes and the Low Salinity Zone:

In-Delta Water Interests

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Introduction

My testimony will summarize scientific information that has been collected since the Water Board's 2009 Staff Report and the 2010 Delta Flow Criteria Report as part of the San Francisco Regional Water Board's efforts to develop Numeric Nutrient Endpoints (NNE) for the San Francisco Bay basin plan. These data indicate to me and the Bay Area Clean Water Agencies (BACWA) that the State Water Board should expand the geographic scope of the NNE process to include the Bay-Delta in the NNE process as recommended by a majority of stakeholder participants in the SF Bay NNE process. While the agencies agree in general on the importance of a regional NNE and sophisticated modeling approaches, this presentation has not been reviewed by the agencies given the short turn-around time for generating presentations.

As cited on their website, the San Francisco Bay Water Board staff is developing nutrient numeric endpoints (NNE) for the San Francisco Bay Estuary. This effort is part of a statewide initiative, supported by the U.S. EPA Region IX and the State Water Board, to address nutrient over-enrichment in State waters, specifically to develop the NNE framework for streams and lakes and for California's coastal estuaries. The process for developing nitrogen and phosphorus nutrient criteria for California started in 1998 with the publication of the U.S. Environmental Protection Agency's *National Strategy for the Development of Regional Nutrient Criteria* (USEPA, 1998). The Water Board is developing a set of NNEs that drive their water quality programs. A stakeholder advisory group (SAG) helps guide the development of the San Francisco Bay Estuary NNE. This process has developed a significant new synthesis about processes in the San Francisco Bay[1]. Since that synthesis, further studies are ongoing, led by Drs, David Senn and Martha Sutula. Dr. Senn is also synthesizing data as part of a State Water Contractors, Water Board Surface Waters Ambient Monitoring Program (SWAMP), and Central Contra Costa Sanitary District (CCCSD) joint research project in Suisun Bay. BACWA is participating as a member of the SAG and the Suisun Bay studies, and this presentation draws on the presentations of Drs. Senn and

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[1] Lester McKee, Martha Sutula, Alicia Gilbreath, Julie Beagle, David Gluchowski, and Jennifer Hunt. 2011. Numeric Nutrient Endpoint Development for San Francisco Bay Estuary: Literature Review and Data Gaps Analysis. Available at http://www.waterboards.ca.gov/sanfranciscobay/water_issues/programs/planningtmdls/amendments/estuarineNNE/644_SFBayNNE_LitReview%20Final.pdf

Sutula.The ongoing NNE process has made me aware of the following points that I would like to share with the State Water Board:

1. **It is helpful to evaluate nutrient issues in the Delta and Suisun Bay in a larger temporal and spatial context.**

San Francisco Bay and the Delta have similar enough concentrations of nutrients that it is important to be able to explain any particular experiment's findings in the context of the whole Bay during the last 50 years when extensive high-quality data first became available. On a temporal scale, we see that Bay nitrate and ammonium have been remarkably stable (Table 1 below). The big changes have been due to the large nitrification projects in the Lower South Bay at San Jose, Sunnyvale, and Palo Alto (South Bay segment). There may also be a bit of a signal in Suisun Bay with the significant increase in population there.

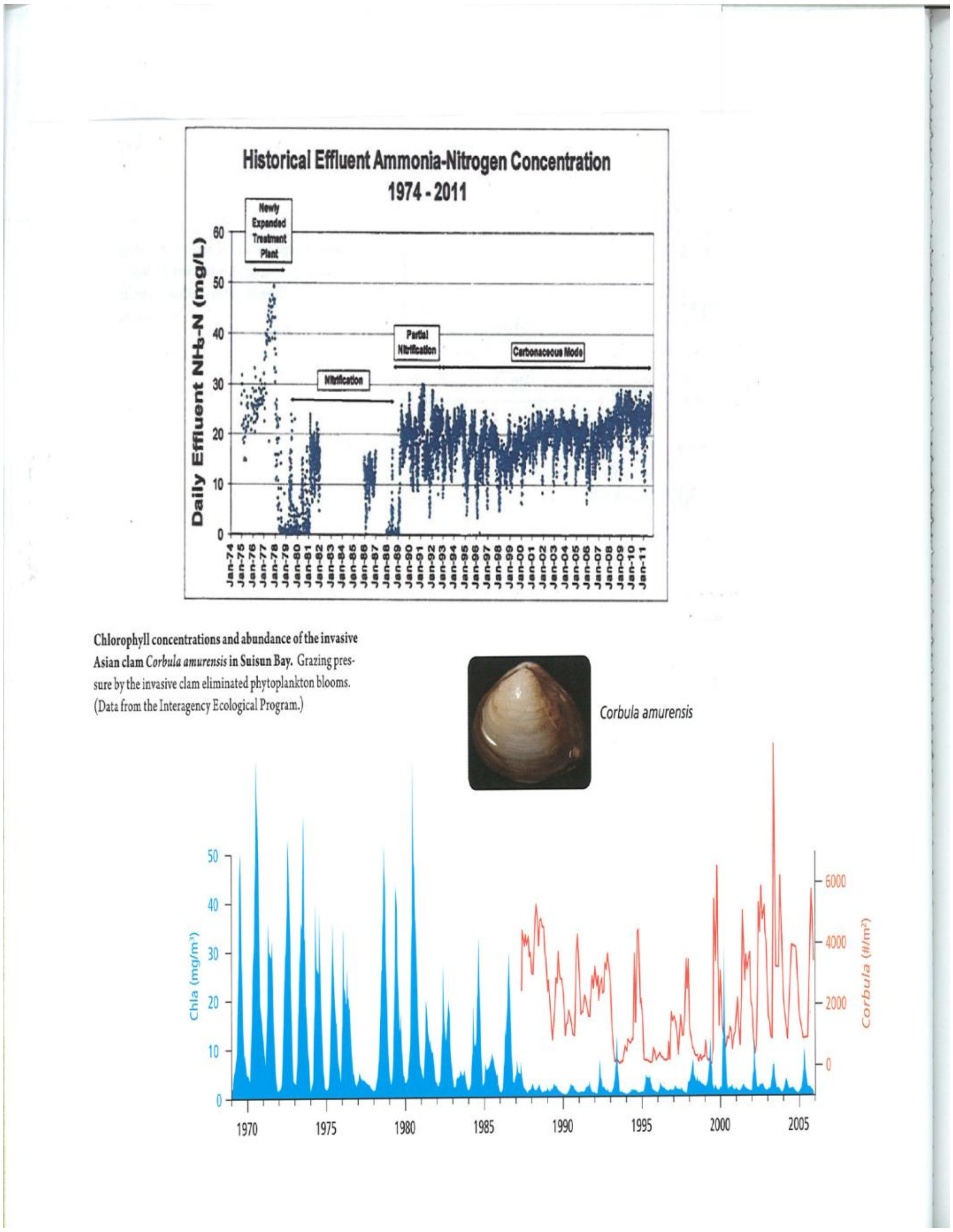
Table 1. Historic and Current Nutrient Concentrations in Bay Segments[2]

Segment	(NOx) – N (mg/L)		Ammonium-N (mg/L)	
	1958- 64	Recent	1958-64	Recent
Suisun Bay	0.31	0.38	0.13	0.11
San Pablo Bay	0.35	0.32	0.15	0.09
Central Bay	0.24	0.26	0.15	0.09
South Bay	0.34	0.35	0.12	0.08
Lower South Bay	0.35	0.70	3	0.09

In addition, we have inadvertently conducted natural experiments in the Bay that have dramatically changed the way the Bay functions. Probably the best-known example is the dramatic decline in Suisun Bay phytoplankton in the late 1980s with the invasion of the Asiatic clam. There was another natural experiment conducted during that period that is quite relevant to this issue. From 1980-1989, CCCSD provided nitrification of its effluent discharged into Suisun Bay. Ammonia discharges to Suisun Bay were quite reduced with no apparent effect on chlorophyll concentrations—if anything chlorophyll concentrations were lower in the early 1980s compared to the previous decade, and then declined dramatically with the introduction of the Asiatic clam (Figure 1).

[2] Recent data from McKee et.al (2011), Table 5.8.1. Historic data from 1975 San Francisco Bay Basin Plan citing UC Berkeley study SERLReport 67-2.

Figure 1. Ammonia concentrations in the CCCSD effluent show nitrification during the time when chlorophyll concentrations were high in Suisun Bay before exotic clam grazing reduced chlorophyll concentrations.[3]



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[3] CCCSD data from an internal memorandum from Ba Than to James Kelly on December 29, 2011 is overlain with Figure 4 from Werme, C., Taberski, K., McKee, L., Dugdale, D., Hall, T., and M. Connor. 2012. A growing concern: Potential effects of nutrients on Bay phytoplankton. Pulse of the Estuary. http://www.sfei.org/documents/pulse-estuary-2011

The impact of clam grazing seems to overwhelm explaining the trends simply with ammonia concentrations (Figure 2).

Figure 2a. Ammonium concentrations (uM) over the last 40 years in Suisun Bay (IEP station D7) show few long-term trends.[4]

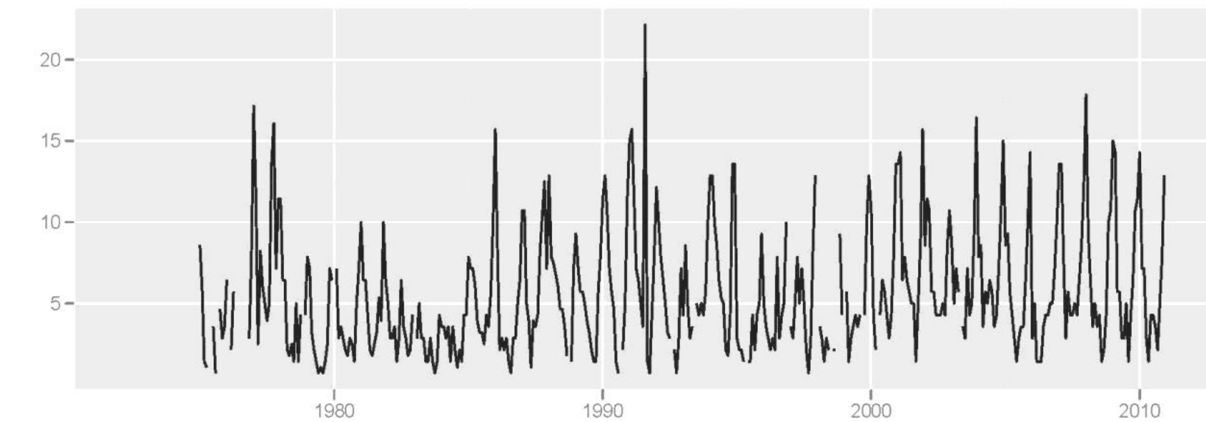
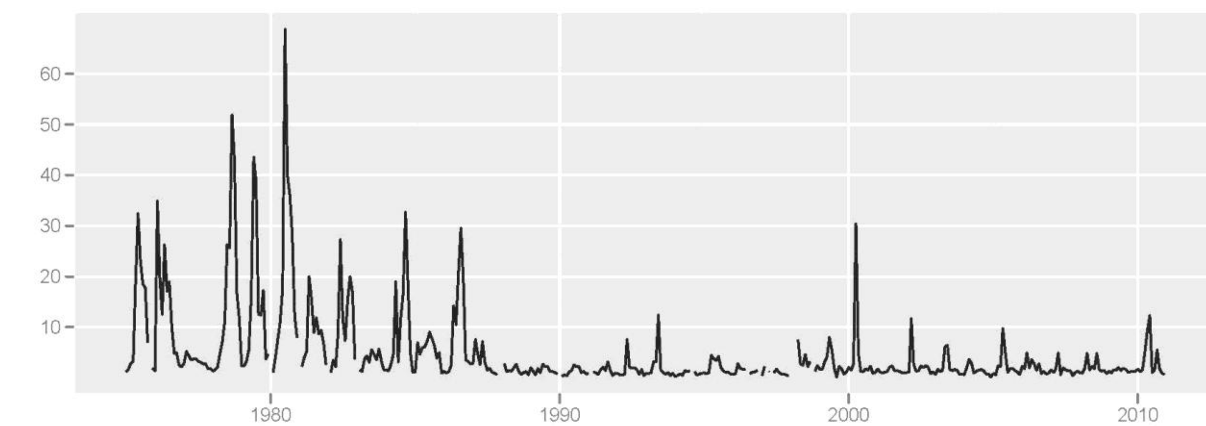


Figure 2b. Chlorophyll concentrations (ug/l) over the last 40 years in Suisun Bay (IEP Station D7) show little correlation with ammonium.

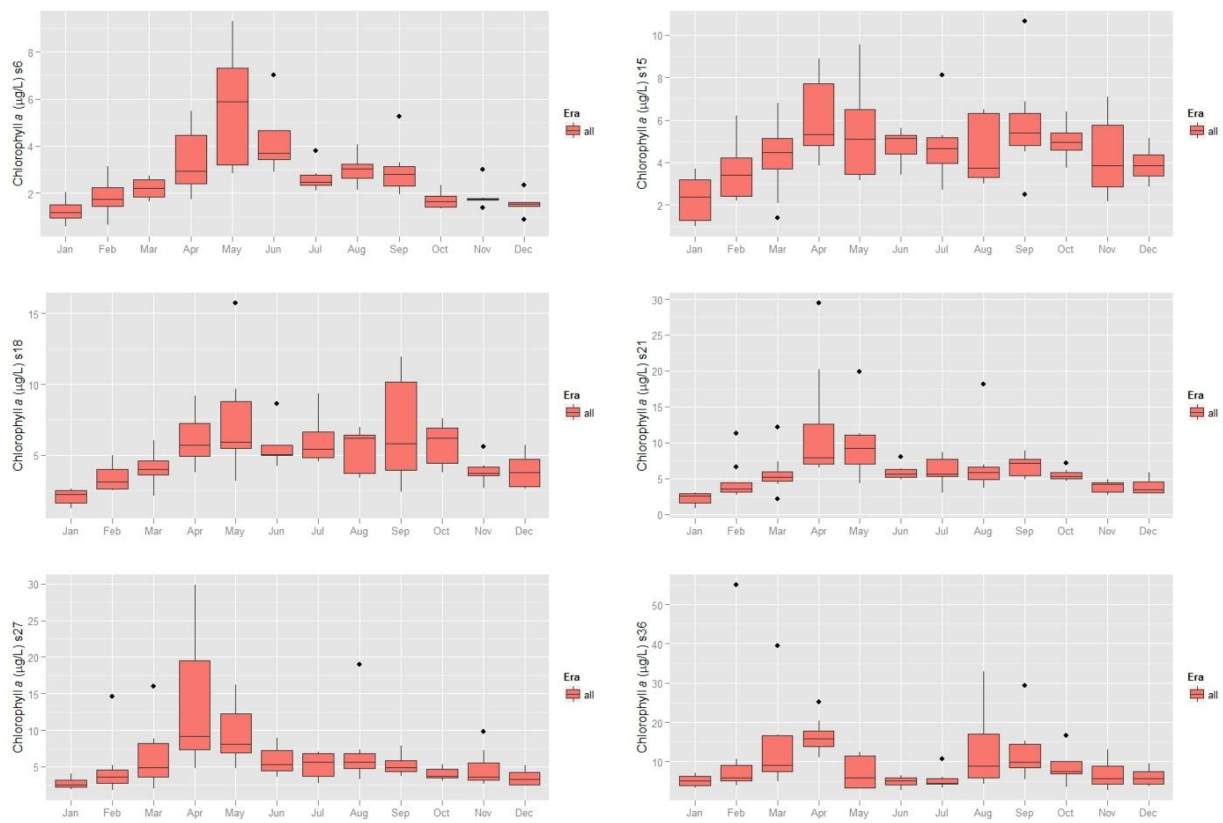


[4] Graphic from D. Senn using IEP Data.

2. **Bay-wide spatial patterns are also important to our understanding of nutrient processes in the Bay.**

Figure 3 shows that chlorophyll concentrations increase on a gradient from the Delta to the South Bay. While there are important properties that vary along this gradient, the most significant seem to be water residence time and grazing pressure. A sophisticated numerical model would help elucidate this causality.

Figure 3. The chlorophyll (ug/l) response to ambient nutrients increases along a gradient from the Delta to San Jose. [5] Data extend from Suisun Bay to San Jose (moving from upper left to bottom right sequentially, :S6=Roe Island, S15=Pt. San Pablo, S18=Pt. Blunt, S27=SFO,S36=Calaveras Pt.)

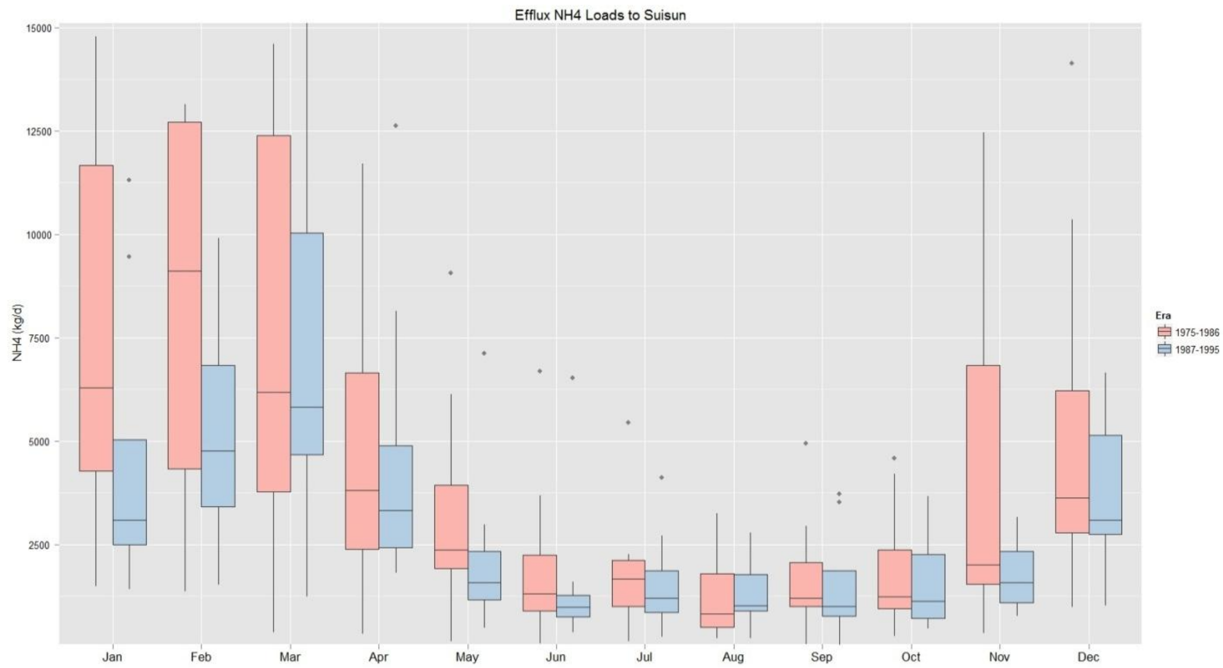


[5] Graphic from D. Senn based on data from USGS. http://sfbay.wr.usgs.gov/access/wqdata/

3. **Seasonal patterns yield insight into crucial Bay processes that are not well characterized.**

In addition to changes over years, seasonal patterns are crucial to understand the response and sources of nutrient loadings to the Bay. Figure 4 shows that winter loads of ammonia are 2-3 times higher than summer loads. Wastewater loads do not vary significantly over the year. The data point to the importance of non-point source loads to the Bay, and nitrification and denitrification processes occurring in the Delta. Again, a sophisticated Bay nutrient model would help elucidate the importance of these processes.

Figure 4. Seasonal loading estimates to Suisun Bay demonstrate the importance of our incomplete understanding of sources and processes of nutrient transformation in the Bay.[6]



[6] Graphic from D. Senn based on data from IEP.

4. **There are extensive ongoing studies of nutrient issues in the Delta and Suisun Bay that will modify our understanding of these issues.**

Monitoring programs overseen by various state agencies (IEP, SWAMP, permit requirements for CCCSD) have resulted in a plethora of new studies in the Delta and Suisun Bay. Some of the preliminary results from these studies are changing our conceptual models of the important drivers of primary production in the Bay and its impact on the zooplankton and fish consumers. It will require some very complicated ecological modeling approaches to yield predictions that resources managers can use with confidence. The Bay-Delta Program has existing policies of "adaptive management" that will require very sophisticated, coordinated implementation by regional managers and scientists.

5. **There is an extensive untapped literature on whether ammonia concentrations inhibit diatoms in estuaries**.

Besides these new publications on San Francisco Bay, there is an extensive worldwide literature on eutrophication issues in estuaries. These data are highly relevant to local policy making. While there is some evidence in the ocean that diatoms are adapted to prefer nitrate to ammonia for growth, there are many counter examples in the northeastern United States (Boston Harbor, Narragansett Bay) where ammonia has been historically discharged. The most compelling case study from Dokai Bay, Japan suggests that diatom communities can adapt to high ammonia concentrations. Work from Paul Harrison's group shows that diatoms in Dokai Bay—a former poster-child for pollution in Kitakyushu, Japan, and now the site of UN training for water quality infrastructure—grow faster at the high ammonia concentrations found there (> 100 uM), far higher than the concentrations found in Suisun Bay or the lower Sacramento River. [7] It is important that any consideration of Delta water quality incorporate a complete evaluation of the issue and not just draw on a few experiments.

Conclusion

Taken together, all this information suggests that the Water Board should expand the existing San Francisco Bay NNE process to include the Delta because

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[7] Tada, K., Suksomjit, M., Ichimi, K., Funaki, Y., Montani, S., Yamada, M. and P.J. Harrison. 2009. Diatoms grow faster using ammonium in rapidly flushed eutrophic Dokai Bay, Japan. Journal of Oceanography 6(2009): 885-891. http://www.springerlink.com/content/x18006221675l828/

1. The Delta and the Bay ecosystem often functions as a closely coupled integrated ecosystem (moreso in some seasons and years than others).
2. Understanding Delta inputs is crucial to understanding Bay processes.
3. Comparing responses of different parts of the Bay and Delta to nutrient inputs and processes improve our overall understanding and predictive ability to manage the Bay and Delta.

In addition, the agencies should pursue an integrated nutrient and ecosystem modeling approach that builds on the flow models developed by DWR and the USGS.