

# Nutrient Forms and Ratios Workshop and White Paper Reading List

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## Review Materials<sup>1</sup>

- \* Berg, G.M. 2015. Physiological Assessment of the “Bad Suisun” Phenomenon: Light and Nutrient Interactions. Report prepared by Applied Marine Sciences for the Central Contra Costa Sanitation District, September.
- \* Brown, L., W. Kimmerer, J. L. Conrad, S. Leismester, and A. Muller-Solger. 2016. Food webs of the Delta, Suisun Bay, and Suisun Marsh: An update on current understanding and possibilities for management. *San Francisco Estuary and Watershed Science* 14(3) 41 pages.
- \* Cloern, J.E., A. Malkassian, R. Kudela, E. Novick, M. Peacock, T. Schraga, D. Senn. 2015. The Suisun Bay Problem: Food Quality or Food Quantity? Suisun Synthesis II Report Section 6. Prepared for the San Francisco Bay Nutrient Management Strategy. (Note: previously published in the Interagency Ecological Program for the San Francisco Estuary (IEP) Newsletter, 27(1)15-33) [Found within SuisunSynthesis2\_November2016\_DRAFT document, pg. 226 of pdf]
- \* Dugdale, R., F. Wilkerson, and A. E. Parker. 2015. The “Ammonium Paradox”: A Summary of More than a Decade of Research into Phytoplankton Processes and Nitrogen Relationships in the Northern San Francisco Estuary. Suisun Synthesis II Report Section 2. Prepared for the San Francisco Bay Nutrient Management Strategy. *Note: The geographic scope of this document includes the entire San Francisco Estuary and is wider than the scope of the Workshop, which is focused on the Delta and Suisun Bay.* [Found within SuisunSynthesis2\_November2016\_DRAFT document, pg. 1 of pdf]
- \* Glibert, P.M. 2015. Re-examining the paradigm of lack of nutrient regulation of primary productivity and trophodynamics of the San Francisco Bay Delta: The view beyond classic nutrient limitation and the importance of dynamic metabolic regulation, the “paradox of enrichment,” and ecological stoichiometry. Suisun Synthesis II Report Section 3. Prepared for the San Francisco Bay Nutrient Management Strategy. *Note: The geographic scope of this document includes the entire San Francisco Estuary and is wider than the scope of the Workshop, which is focused on the Delta and Suisun Bay.* [Found within SuisunSynthesis2\_November2016\_DRAFT document, pg. 70 of pdf.]
- \* Kraus, T. E.C., K. D. Carpenter, B. A. Bergamaschi, A. E. Parker, E. B. Stumpner, B. D. Downing, F. P. Wilkerson, C. Kendall, and T. D. Mussen. 2016. Drivers of phytoplankton in the Sacramento River: Comparing phytoplankton abundance and composition in the presence and

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<sup>1</sup> The Review Materials include documents to prepare panel members for the workshop. These documents will provide panel members with a background on Delta nutrient issues.

\* Materials available: <http://sfbaynutrients.sfei.org/books/delta-bay-nutrient-workshop-materials-nov-2016>

absence of treated wastewater effluent. Abstract for the Bay Delta Science Conference November 15-17, 2016 Sacramento. [Note: paper in review. The presentation abstract will be replaced with the published paper when available.]

\* Senn, D., E. Novick, and T. Jabusch. 2014. Research on NH<sub>4</sub><sup>+</sup> inhibition of primary production in Suisun Bay. Suisun Synthesis 1 Report Section 3. Prepared for the San Francisco Bay Nutrient Management Strategy. [Found within Suisun Synthesis I\_Final\_Mar2014 document, pg. 56 of pdf.]

\* Strong, A. 2016. The response of San Francisco-Bay Delta phytoplankton to ammonium, nitrate, and wastewater effluent additions under different light conditions. Chapter 5 Dissertation, Stanford University. [Note: manuscript submitted. The dissertation chapter will be replaced with the published paper when available.]

## **Supplementary Materials**

### **Delta Water and Ecosystem Background**

California Department of Water Resources, 2013. California Water Plan Update 2013, Volume 2 Regional Reports: Sacramento-San Joaquin Delta.

[http://www.water.ca.gov/waterplan/docs/cwpu2013/Final/Vol2\\_DeltaRR.pdf](http://www.water.ca.gov/waterplan/docs/cwpu2013/Final/Vol2_DeltaRR.pdf)

*This report provides background information on Delta hydrology, ecosystems, land and water uses, and ecology. Relevant sections and pages: Statewide Significance pg. D-9 and D-10; Unique Characteristics pg. D-16 through D-26.*

### **Nutrients Status, Trends, and Mass Balances**

Novick, E., R. Holleman, T. Jabusch, J. Sun, P. Trowbridge, D. Senn, M. Guerin, C. Kendall, M. Young, and S. Peek. 2015. Characterizing and quantifying nutrient sources, sinks, and transformation in the Delta: synthesis, modeling, and recommendations for monitoring. Report prepared for the California Dept. Water Resources.

<http://sfbaynutrients.sfei.org/books/dwr-contract-deliverable>

*Recommended for panel review is the main report and Appendices 2 (Nutrient Variability) and 3 (Nutrient Loads and Transformations).*

### **Delta-Estuary Nutrient Research**

Dugdale, R. C., F. P. Wilkerson, and A. E. Parker. 2013 A biogeochemical model of phytoplankton productivity in an urban estuary: The importance of ammonium and freshwater flow. *Ecological Modeling* 263:291-307.

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

Glibert PM., R. C. Dugdale, F. Wilkerson, A. E. Parker, J. Alexander, E. Antell, S. Blaser, A. Johnson, J. Lee, T. Lee, S. Murasko, and S. Strong. 2014a. Major – but rare – spring blooms in 2014 in San Francisco Bay Delta, California, a result of the long-term drought, increased

residence time, and altered nutrient loads and forms. *Journal of Experimental Marine Biology and Ecology* 460: 8–18. doi: [10.1016/j.jembe.2014.06.001](https://doi.org/10.1016/j.jembe.2014.06.001).

Glibert P.M., F. P. Wilkerson, R. C. Dugdale, A. E. Parker, J. Alexander, S. Blaser, and S. Murasko . 2014b. Phytoplankton communities from San Francisco Bay Delta respond differently to oxidized and reduced nitrogen substrates - even under conditions that would otherwise suggest nitrogen sufficiency. *Frontiers in Marine Science*. doi: 10.3389/fmars.2014.00017

Glibert, P.M., D. Fullerton, J.M. Burkholder, J.C. Cornwell, and T. M. Kana. 2011. Ecological stoichiometry, biogeochemical cycling, invasive species, and aquatic food webs: San Francisco Estuary and Comparative Systems. (review paper)

Lee, J., A. E. Parker, F. P. Wilkerson, and R. C. Dugdale. 2015. Uptake and inhibition kinetics of nitrogen in *Microcystis aeruginosa*: Results from cultures and field assemblages collected in the San Francisco Bay Delta, CA. *Harmful Algae* 47:126-140.

Lucas, L.V. and J.K. Thompson. 2012. Changing restoration rules: Exotic bivalves interact with residence time and depth to control phytoplankton productivity. *Ecosphere* 3(12)117. DOI: 10.1890/ES12-00251.1

Parker, A. E., V.E. Hogue, F.P. Wilkerson and R.C. Dugdale. 2012a. The effect of inorganic nitrogen speciation on primary production in the San Francisco Estuary. *Estuarine Coastal and Shelf Science* 104: 91-101.

Parker, A. E., R. C. Dugdale and F.P. Wilkerson. 2012b. Elevated ammonium concentrations from wastewater discharge depress primary productivity in the Sacramento River and the Northern San Francisco Estuary. *Marine Pollution Bulletin* 64:574-586.

\*Van Nieuwenhuysse, E., R. Dahlgren, B. Bridges, and H. Horner. 2011. Nutrient enrichment experiments in the Delta-Mendota Canal. Final Report prepared for the US Bureau of Reclamation, Sacramento. April.

Van Nieuwenhuysse, E. 2007. Response of summer chlorophyll concentration to reduced total phosphorus concentration in the Rhine River (Netherlands) and the Sacramento-San Joaquin Delta (California, USA). *Can. J. Fish. Aquat. Sci.* 64: 1529-1542. Doi: 10.1139/F07-121.

Wilkerson, F. P., R. C. Dugdale, A. E. Parker, S. Blaser, A. Pimenta 2015. Nutrient uptake and primary productivity in an urban estuary: using rate measurements to evaluate phytoplankton response to different hydrological and nutrient conditions. *Aquatic Ecology*. 49(2): 211-233. Doi:10.1007/s10452-015-9516-5.

### **Delta Nutrient Research Plan White Papers on Cyanobacteria, Macrophytes, & Modeling**

To develop the Delta Nutrient Research Plan, Water Board staff and stakeholders began by gathering information and in a series of white papers. The Nutrient Forms and Ratios white paper is part of this effort. White papers have been completed on the following topics:

- A framework for modeling to answer nutrient management questions,
- Factors affecting growth of cyanobacteria in the Delta; and

- Factors controlling growth of submerged and floating aquatic macrophytes.

For the cyanobacteria and macrophyte topics, research recommendations are contained in companion “knowledge gaps” documents.

[http://www.waterboards.ca.gov/centralvalley/water\\_issues/delta\\_water\\_quality/delta\\_nutrient\\_research\\_plan/science\\_work\\_groups/index.shtml#whitepapers](http://www.waterboards.ca.gov/centralvalley/water_issues/delta_water_quality/delta_nutrient_research_plan/science_work_groups/index.shtml#whitepapers)

### **Previous Syntheses of Delta Nutrients and Ecosystem Drivers**

Meyer, J.S., P.J. Mulholland, H.W. Paerl, A.K. Ward. 2009. A Framework for Research Addressing the Role of Ammonia/Ammonium in the Sacramento-San Joaquin Delta and the San Francisco Bay Estuary Ecosystem. A final report to the CALFED Science Program, Sacramento, CA. April.

*Note: the Panel will be updated regarding the progress that has been made since this Framework was written.*

[http://www.science.calwater.ca.gov/pdf/workshops/workshop\\_ammonia\\_research\\_framework\\_final\\_041609.pdf](http://www.science.calwater.ca.gov/pdf/workshops/workshop_ammonia_research_framework_final_041609.pdf)

National Research Council (2012). Sustainable Water and Environmental Management in the California Bay-Delta.. Committee on Sustainable Water and Environmental Management in the California Bay-Delta,. March.

Available: <http://dels.nas.edu/Report/Sustainable-Water-Environment/13394>

*Chapter 3 of the report is a particularly helpful reference for the multiple, interacting drivers that affect phytoplankton and the Delta food web.*

Reed, D., J.T. Hollibaugh, J. Korman, E. Peebles, K. Rose, P. Smith, and P. Montagna. 2014. Workshop on Delta Outflows and Related Stressors: Panel Summary Report. Prepared for the Delta Stewardship Council and Delta Science Program, May.

<http://deltacouncil.ca.gov/sites/default/files/documents/files/Delta-Outflows-Report-Final-2014-05-05.pdf>

*This report was prepared as part of the process for revising flow objectives for the Bay-Delta. Flow objectives are still under development. The Delta Flows panel was asked about the interactions of outflow and other processes. The authors wrote about the data gaps related to drivers of benthos and turbidity and the need to recognize the roles of gradual as well as rapid ecosystem change (examples: decreasing turbidity and spread of *Corbula* clams). The authors commented on the literature regarding ammonia in the low salinity zone, pg. 44-61.*

\*Senn D.B. and E. Novick. 2014. Executive Summary: Suisun Synthesis 1 Report. Prepared for the San Francisco Bay Nutrient Management Strategy.

*Note to panel: The Executive Summary describes recommended next steps for furthering understanding of the roles of nutrients, particularly ammonia in Suisun Bay. [Found within Suisun Synthesis I\_Final\_Mar2014 document, pg. 1 of pdf.]*