Nutrients in the Bay: Science to Inform Management Decisions

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San Francisco Bay (SFB) has higher concentrations of the nutrients nitrogen and phosphorous than many US estuaries due to large inputs from treated wastewater effluent and nonpoint source runoff from the Sacramento and San Joaquin Rivers. Despite its abundant nutrient supply, SFB has exhibited resistance to classic symptoms of nutrient over-enrichment observed in other estuaries, such as large phytoplankton (i.e., algae) blooms and low dissolved oxygen. Beginning in the late 1990s, however, phytoplankton levels began increasing sharply in South Bay, raising concerns that SFB's resistance to high nutrient loads was weakening. In response to those concerns, regulators and stakeholders collaboratively launched the SFB Nutrient Management Strategy (NMS), a multi-year science and monitoring program that will build the scientific foundation to inform major nutrient management decisions for the Bay Area. This presentation will discuss recent results from NMS science activities. One high-priority NMS initiative focuses on harmful algae blooms and the toxins they produce, with studies measuring toxin levels in water and biota throughout SFB, and investigations into toxin sources and conditions that encourage their production, including the potential role played by nutrients. A second major initiative focuses on phytoplankton growth, dissolved oxygen levels, and nutrient cycling, with a geographic focus in the sloughs and tidal creeks of Lower South Bay.

Keywords: nutrients, dissolved oxygen, HABs

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Speaker Biography: David Senn is a Senior Scientist at SFEI, Co-Director of SFEI's Clean Water program, and Lead Scientist for the Bay Area Nutrient Management Strategy. He received his PhD in civil and environmental engineering from MIT, where he studied the interactions between nitrogen pollution and iron and arsenic cycling in contaminated urban lakes. Subsequently, as a researcher at the Harvard School of Public Health, he conducted contaminant fate, transport, and exposure studies, including investigating mercury cycling, bioaccumulation, and human exposure in the Gulf of Mexico. Prior to joining SFEI, from 2007-2011, he worked at the Swiss Federal Institute of Aquatic Science and Technology coordinating an interdisciplinary project studying the ecological impacts of large dams in the Zambezi River Basin in southern Africa.

Future Nutrient Loads to the Estuary and Approaches for Monitoring

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Nutrient delivery to the San Francisco Estuary (SFE) and California coastal waters already have been significantly altered by changes in population and land use resulting in, for example, changes to the timing and location of phytoplankton blooms and the extent of aquatic vegetation. Continued population growth and anticipated changes in agricultural practices and intensity are expected to accelerate these changes. As a community, we must anticipate and plan for these changes.

Using a novel modeling approach, the USGS LandCarbon project generated prospective annual future land use and land cover maps using a range of population and development scenarios (IPCC scenarios A1, A1b, and B1) to the year 2100. These projected land cover and land use maps allowed us to assess the potential for changes in the delivery of nutrients and sediments from upstream areas to estuaries and coastal waters for the continental United States using the SPARROW model, calibrated on historical water quality measurements.

Model results suggest that we should anticipate significantly greater fluxes of nutrients to the San Francisco Estuary. For example, nitrate loading to SFE is projected to increase up to 50% by 2050, depending on the development scenario. Anticipating such increases should be part of the ongoing environmental planning, data collection, and restoration activities in SFE. The results for the different scenarios and opportunities for appropriate monitoring of these changes will be discussed.

Keywords: nutrients, nitrate, phosphate, eutrophication, land-use change, population change, climate change

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Speaker Biography: Dr. Brian Bergamaschi is a research biogeochemist with the USGS California Water Science Center and adjunct Faculty at California State University Sacramento. He received a Ph.D. in Chemical Oceanography from the University of Washington, in Seattle, WA, where he specialized in analyzing the sources and fates of natural organic material in the environment. His main interests are in understanding processes of carbon cycling in aquatic environments and related biogeochemical processes. His particular emphasis is on developing methods for quantifying the interactions between physical and biogeochemical processes. His research ranges in scale from light-mediated molecular transformations, to tidally-driven wetland fluxes, to effects of changing continental-scale fluxes on coastal carbon processes. His current projects largely focus on the effects of wetland restoration on aquatic habitat quality and carbon cycling.

Adaptive Management of Nutrients in the Delta: Integrating Science and Policy

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The mission of Sacramento Regional County Sanitation District (Regional San) is to serve its approximately 1.4 million customers by protecting public health and the environment through reliable and safe conveyance, treatment, and disposal of wastewater from residential, industrial, and commercial sources throughout the greater Sacramento metropolitan area in the most cost effective manner, now and in the future. The wastewater travels through 169 miles of interceptor pipelines to the Sacramento Regional Wastewater Treatment Plant near Elk Grove, where approximately 150 million gallons of wastewater are treated daily, as permitted by the Central Valley Regional Water Quality Control Board, prior to discharge into the Sacramento River. Regional San is conducting the EchoWater project, a greater than $1.5 B upgrade to the treatment plant. EchoWater responds to recent changes to Regional San's National Pollutant Discharge Elimination System permit, and involves an accelerated construction program that will result in new treatment processes being operational for ammonia removal by 2021, and for filtration and enhanced disinfection by 2023. The project will produce improved discharged water quality, and increased volumes of recycled water for reuse. Regional San staffs participate in numerous water management forums and science/policy work groups in the Delta and San Francisco Bay areas, promoting the application of sound science to management decisions. We encourage the integration of science and policy to inform management actions that are outcome-based. In 2013-2014 Regional San helped fund and participated in a large-scale adaptive management experiment to test the potential effects of discharged, treated wastewater on phytoplankton community health in the Sacramento River. This multi-day experiment tested how phytoplankton could respond to the massive reduction in dissolved ammonia concentrations that will result from EchoWater. We consider adaptive management to be a powerful scientific and policy approach for testing a spectrum of future management actions in the Delta.

Keywords: Wastewater treatment, nutrients, adaptive management, science, policy, outcome-based policy

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Speaker Biography: Lisa Thompson was appointed Chief Scientist for both Regional San and Sacramento Area Sewer District in 2014. As Chief Scientist, she leads and supports Regional San's efforts regarding complying with permit related studies, Delta research, and she also serves as a technical resource for all scientific research needs for both Districts. Thompson was previously employed by the University of California, Davis for 13 years, where she served in various positions including Specialist in Cooperative Extension in the Wildlife, Fish, and Conservation Biology Department, and as Director of the Center for Aquatic Biology and Aquaculture. Thompson holds a Bachelor of Science degree in Zoology from the University of Toronto, a Master of Science degree in Biology from McGill University, in Montreal, Canada, and a Doctorate degree in Zoology from the University of British Columbia.

POTWs' Role in the Nutrient Management Strategy for San Francisco Bay

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San Francisco Bay is a nutrient-enriched estuary. Nonetheless, dissolved oxygen concentrations found in the Bay's subtidal habitats are much higher and phytoplankton biomass and productivity are substantially lower than expected in an estuary with such high nutrient enrichment. This implies that eutrophication is potentially controlled by processes other than straightforward nutrient-limitation of primary production. However some evidence suggests the historic resilience of San Francisco Bay to the harmful effects of nutrient enrichment is weakening. If true, management actions may be needed to reduce the nutrient loadings to the Bay. In response, the Water Board has developed a Nutrient Management Strategy (NMS) which is now being implemented.

Studies estimate that two third of nutrient loads to the Bay are from POTW discharges. Since most wastewater treatment plants are not designed to remove nutrients, regulations mandating nutrient removal would result in large capital improvement programs by many POTWs. It is therefore very important to conduct the needed scientific studies to understand if the Bay is heading towards impairment and if so what should be done. To this end POTWs in the Bay Area are supporting a robust science program as part of the NMS that will help determine if impairment is imminent and if management actions are required to limit the amount of discharges of nutrients.

Through their regional coalition, the Bay Area Clean Water Agencies (BACWA), POTWs have negotiated a nutrient watershed permit, are providing funds to further the scientific studies, and are participating in the governing body overseeing the NMS. This presentation discusses the role of Bay Area POTWs in the regulatory, technical and governance aspects of the NMS and describes investigations being conducted that will provide insight into how POTWs could reduce nutrients if such requirements are ultimately needed.

Keywords: nutrient management strategy, nutrient loadings, POTW, BACWA, nutrient regulations, permit

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Speaker Biography: Laura Pagano is the Regulatory Program Manager (Wastewater) for the San Francisco Public Utilities within the City and County of San Francisco. She is also the Chair of the Bay Area Clean Water Agencies (BACWA) a Joint Powers Agreement among the major Publicly Owned Treatment Works (POTW) in the nine county Bay Area. BACWA represents 46 POTWs in the Bay Area under the regulatory jurisdiction of the San Francisco Bay Regional Water Quality Control Board.