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Scientific Basis to Assess the Effects of Nutrients on San Francisco Bay Beneficial Uses

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EXECUTIVE SUMMARY

San Francisco Bay (SFB) has long been recognized as a nutrient-enriched estuary; however, until recently, it has exhibited resistance to symptoms of nutrient overenrichment due to a number of factors such as high turbidity, strong tidal mixing, and grazing by bivalves. Recent observations have reinforced the need to identify numeric water quality objectives and management actions to protect SFB from the potential effects of nutrient over-enrichment. The purpose of this work was to develop a quantitative framework, hereto referred to as an assessment framework, to assess eutrophication in the SFB, based on indicators of dissolved oxygen (DO), phytoplankton biomass (chlorophyll-a), gross primary productivity, the prevalence of harmful algal blooms (HAB) and toxins.

A group of experts in the ecology of SFB, as well as international experts in assessment frameworks (AF) and nutrient criteria, worked in concert to define core principles for the AF. These principles include the geographic scope, recommended Bay segmentation of subembayments for assessment, and the protocols and recommended spatial and temporal frequency of monitoring that would support use of the framework to assess nutrient effects on SFB. A quantitative scheme was developed to classify SFB subembayments in tiers of ecological condition, from very high to very low, based on risk of potential adverse effects of nutrient overenrichment and eutrophication. Decisions on classification bins were supported by a combination of existing literature and guidance, quantitative analyses of existing SFB data from the USGS research program, and expert best professional judgment. Analyses of two decades of phytoplankton species composition, chlorophyll-a, and dissolved oxygen (DO), and 3 years of toxin data from solid phase adsorption toxin tracking (SPATT) samplers were used to support decisions on the AF and demonstrated: 1) significant increases in chlorophyll-a, declines in DO, and a high prevalence of HAB species and toxins across most SFB subembayments and 2) strong linkage of increasing chlorophyll-a to declining DO and HAB abundance. Statistical approaches were used to define thresholds in chlorophyll-a relating to increased risks of HABs and declining DO. These thresholds were used, in combination with expert best professional judgment, to develop an AF classification scheme. A qualitative summary of uncertainty associated with each indicator was made for the purpose of focusing future research, monitoring, and modeling on AF refinement.

The AF is intended to provide a decision framework for quantifying the extent to which SFB is supporting beneficial uses with respect to nutrients. This AF is comprised of three important elements: 1) a set of conceptual models that defines what a problem would look like in SFB, if it occurred, 2) a set of core principles supporting the AF, and 3) classification tables. The AF supports and is supported through the other major science elements. The conceptual models and AF core principles provide a sound scientific foundation for informing modeling and monitoring. Through early interactions with the stakeholder community, these two components of the AF appear to have the greatest consensus and the least "uncertainty."

The classification scheme is a critical element of the AF, because it represents a quantitative and

transparent mechanism through which SFB data can be interpreted to assess, nutrient-related beneficial use support. Given its importance, the authors of this document fully acknowledge the uncertainty in the AF classification scheme and need for refinement, through multiple iterations of basic research, monitoring, and modeling. We suggest that the near-term use of the AF

classification system be focused on a scientific "test drive" focused on understanding how to collectively use and improve efficiencies for assessment, monitoring and modeling. The "test drive" of the AF can be conducted in tandem with research, monitoring, and modeling to improve the scientific foundation for the AF, aimed at the following six major recommended actions:

1. Improve the scientific basis for nutrient-related segmentation of SFB.

2. Reduce sources of uncertainty in chlorophyll-a, HAB abundance and toxin classification by: 1) Better assessment and characterization of the ecological and human risk of HABs in SFB, 2) Co-location of chlorophyll-a and monitoring of toxins in Bay surface waters, shellfish and SPATT to improve documentation of linkage of chlorophyll-a to HAB toxin concentrations, 3) Expand SPATT samplers to include other toxins and conduct better validation of SPATT toxin data relative to surface waters or mussel toxin tissues, 4) Assemble a scientific workgroup to evaluate and provide recommendations on the chronic effects of HAB toxins, and 5) Improve monitoring through better spatial and temporal coverage of HAB data to link chlorophyll-a to DO.

3. Optimize spatial and temporal sampling of AF indicators to best align quality of the information produced, while balancing costs, logistics, and power to detect trends.

4. Improve the scientific basis for dissolved oxygen classification and monitoring in future iterations of the AF. Current recommendations focus on indicators of phytoplankton. We recommend: 1) synthesis of DO expectations for SFB species types and the seasonal use of specific habitat types (deep channel, shallow subtidal, tidal sloughs, etc.) within SFB subembayments; 2) improved characterization of the diel variability of DO at key points within the deep water and shallow margin habitat of each subembayment in order to better characterize support of species and habitats; and 3) improved mechanistic understanding of the physical and biological factors influencing DO within and between the deep channel and shallow water margin habitat.

5. Include diked baylands, restored salt ponds and tidal sloughs in future iterations of the AF, which is currently focused on open water habitats.

Full Text:

http://ftp.sccwrp.org/pub/download/DOCUMENTS/TechnicalReports/864_SFBayAssessmentFramework.pdf