Monitoring Water Quality in the San Francisco Bay-Delta Using High-resolution Remote Sensing

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The San Francisco Bay Delta is a major source of freshwater for California and a profoundly human-impacted environment. The water quality monitoring that is critical to management of this important water resource and ecosystem relies primarily on a system of fixed water-quality monitoring stations, but the limited spatial coverage often hinders understanding. Here, we demonstrate how the spatial variability of important water quality indicators can be derived using the latest remote-sensing technology. Hyperspectral radiometry from the airborne Portable Remote Imaging SpectroMeter (PRISM) was used to derive high-resolution (~2-m scale) spatial distributions of turbidity, dissolved organic carbon (DOC) concentration, and chlorophyll-a concentration in a region influenced by wetlands. Furthermore, filter-passing methylmercury (MeHg) vs. DOC relationships were developed for co-collected *in-situ* samples, which allowed for the development of high-resolution maps of MeHg concentration in surface waters of the study area. Our results demonstrate how high-resolution remote sensing can be used to inform management and policy development by facilitating the detection of point- and non-point-source pollution and providing data to help assess the complex, diffuse impacts of wetland restoration, and climate change on water quality and ecosystem productivity in highly dynamic and heterogeneous systems such as estuaries.

Keywords: Water quality, imaging spectroscopy, remote sensing, turbidity, DOC, chlorophyll-a, methylmercury

Poster Topic: Nutrients

Nutrients Affecting the Water Quality in State Water Project Supplies

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Nutrients Affecting the Water Quality in State Water Project Supplies, Marcia Scavone-Tansey, Environmental Scientist, CDWR, DES, MWQI

A certain level of nutrients is necessary for biological production and, therefore, vital for healthy ecosystem function. Excessive nutrients, however, can cause too much production and lead to adverse effects. The presence of nutrients in aquatic systems promotes primary productivity, which can clog filters at the water treatment plant and waterways, block sunlight to the below-surface layers of the water column, and absorb dissolved oxygen in the water that could be available for aquatic life. In addition, some algae species are associated with undesirable compounds, such as geosmin and 2-methylisoborneol (MIB), which produce objectionable odors and tastes. Species of cyanobacteria, such as Microcystis, produce toxins that may be harmful to humans.

The objective of this initial study is to understand the sources of nutrients to the State Water Project, and the nutrient transformations and changes in conveyance structures. This work could lead to better control of algal and macrophyte growth, and could potentially lead to development of a nutrient component of the aqueduct extension model.

Our approach is to obtain data available from the Water Data Library (WDL), DWR O&M Division, and other sources, and develop a database and graphs for locations along the aqueduct including the North and South Bay Aqueducts, Delta inflows, Aqueduct Inflows, and the branches of the SWP. The following water quality constituents were included in the analysis: Nitrate + Nitrite, Nitrate, Ammonia, Total Kjeldahl Nitrogen, Total Nitrogen (TKN + Nitrate + Nitrite), Total Phosphorus, and Dissolved Orthophosphate. The partial results are analyzed in this poster.

Keywords: Nutrient, Nitrate, Nitrate+Nitrite, Ammonia, TKN, Nitrogen, Phosphorus, Orthophosphate

Poster Topic: Nutrients

Characterization of and Potential Mechanisms for Low Dissolved Oxygen in the Sloughs of San Francisco Bay

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The southern part of San Francisco Bay (SFB), Lower South Bay (LSB), is a collection of deep and shallow sub-tidal habitats, intertidal mudflats, and a large area of wetlands undergoing restoration which exchange with open SFB via many shallow sloughs. Dissolved oxygen (DO) has historically been monitored 1-2x monthly in the deep channel of LSB and is typically 6-8 mg/L despite high nutrient loading. However, recent high-frequency data demonstrate that DO in the deep channel can dip below 5 mg/L. We hypothesize this is caused by exchange with low DO water in sloughs and wetlands along the periphery. These regions have not been systematically monitored to date, but initial observations at one moored slough station show DO frequently drops below 5 mg/L and reaches concentrations as low as 1-3 mg/L; the severity and duration of these low-DO events is in part influenced by spring/neap tidal cycles. At this same station, elevated chlorophyll-a (chl-a) concentrations on ebb tides, 5-10x higher than observed in open SFB, suggest that there is an external source of organic matter. In this project, we established a series of continuous sensors at slough and deep channel sites and also collected high-spatial resolution data and vertical profiles to answer the following questions: (1) How do DO and chl-a concentrations in slough habitats vary in space (along channel and vertical) and in time (tidal to seasonal time scales)?; (2) What is the severity, extent and duration of low-DO events, and what are controlling mechanisms (i.e., organic matter exported from wetlands vs. in situ respiration)?; and (3) How does connectivity with sloughs and wetlands affect open Bay conditions? We present our findings from the first year of observations, evaluate the relative importance of different organic matter sources, and explore implications for DO, carbon and nitrogen budgets in LSB.

Keywords: Nutrients, dissolved oxygen, high-frequency monitoring, South Bay

Poster Topic: Nutrients

Fixed-Station Measurements and Synoptic Spatial Characterization Provide Insights into Organic-Matter, Nutrient, and Algal-Pigment Dynamics in the San Francisco Bay-Delta

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Continuous water-quality measurements (nutrients, organic matter, turbidity, algal pigments, dissolved oxygen, pH, temperature, conductivity) on autonomous and Lagrangian measurement platforms in the San Francisco Bay Delta (Delta), have improved our knowledge of important biogeochemical and eco-hydrological processes. The Delta is naturally, hydrodynamically complex and affected by human (wastewater and agricultural discharge, water withdrawals, land-surface alterations) and natural perturbations (floodplain and riparian interactions, wind, precipitation, snowmelt), which add complexity across eco-hydrological and water-management domains. Biogeochemical change can occur in the Delta in a matter of minutes to hours, with attendant longer term changes in the ecology of aquatic habitats and human use of the resource. Autonomous water-quality measurements collected over fine temporal and spatial scales help to effectively identify important drivers of biogeochemical processes in the Delta. An established network of autonomous, continuous water-quality monitoring stations in the Delta operated by the USGS, Sacramento, CA, currently provides temporally rich data at fixed locations. The fixed-station measurements reveal complex, hydrodynamically driven changes in water quality, useful to describe habitat conditions for pelagic organisms and to guide future tidal marsh restoration efforts in the delta.

To complement the fixed-station measurements, spatially dense data monitoring using a boat equipped with a GPS time-stamped high-frequency flow-through monitoring system, allow for real-time spatial mapping. Here, we present examples from the fixed-station monitoring network, combined with boat based Lagrangian measurements. We find that real-time mapping in concert with fixed-station monitoring is useful for identifying sources and sinks of nutrients and organic material, and to identify important biogeochemical drivers relating to pelagic habitat quality, algal productivity, and foodweb dynamics.

Keywords: Water quality, Nitrate, Mapping, Organic Matter, Algal Pigments

Poster Topic: Nutrients