Bathymetric Mapping for the 2015 False River Barrier: Solving Problems with Better Data

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Bathymetric monitoring was an integral part of the planning and construction of the False River drought barrier. The primary goal of the monitoring was to allow for the identification of sediment movement impacts in nearby channels. The Department of Water Resources, North Central Region Office made multiple river bed measurements in these channels before, during, and after the barrier was in place. Additionally, the data was useful for underwater hazard identification, hydrodynamic computer modeling, barrier site planning, engineering design, construction monitoring, flow monitoring, levee stability monitoring, and sediment impact evaluations. Some unexpected findings may change the way we think about the Delta's waterways.

Keywords: Bathymetry, drought barrier, False River, Multibeam, scour, sedimentation, monitoring, hydrodynamics
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Salinity Response, Hydrodynamic Change and Performance Limiters under the EDB and 2015 Hydrology

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This presentation describes changes in the Bay-Delta induced by the Emergency Drought Barrier and associated 2015 low flow hydrology. We describe the hydrologic setting for the year and review the tidal pumping mechanism targeted by the EDB to reduce salinity intrusion. Through a synthesis of 3D modeling and data analysis we demonstrate that the EDB was successful in shutting down tidal pumping, preventing salinity increase landward of the barrier after closure. It also changed net and tidal flow patterns around Franks Tract. Conditions at closure have a persistent influence on barrier performance for several months. Although the mid-Delta experienced further subsequent freshening, the pace was slow. We show how the rate of freshening is modulated by pumping and by very limited lateral mixing in eastern Franks Tract and between Old and Middle Rivers. An episode of increased pumping in early September demonstrates how slightly higher pumping rates accelerate freshening. The limited lateral mixing in Franks Tract is explainable by wind and submerged aquatic vegetation, their contributions being confounded but dependable seasonally. We conclude by describing monitoring that would help assess a future EDB effort and confirm some of the nuanced flow features around Franks Tract. We describe how the unknowns we have identified affect the robustness of early season design support.

Keywords: Hydrodynamic Modeling, Salinity Intrusion, Emergency Drought Barrier
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High Speed Mapping of Water Isotopes with Simultaneous Water Quality Measurements to Determine Effects of the Emergency Drought Barrier

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Installation of the Emergency Drought Barrier (EDB) in West False River in 2015 to limit salinity penetration into the Central Delta and thus to water intakes in the south Delta also affected other water quality parameters with repercussions on food web dynamics. For example, the hydrologic change impacted water residence time, nutrient gradients and phytoplankton productivity. To investigate potential impacts of the EDB, we used high-speed boat transects designed to continuously measure nitrate, chlorophyll, dissolved organic matter fluorescence, and ancillary water quality parameters (temperature, pH, specific conductance, dissolved oxygen, turbidity) at high frequency (1 second) sampling rates. Measurements were made both with the EDB in place and after its removal. High frequency water isotope measurements (δ^2H, $\delta^{18}O$) were also collected simultaneously to assess the distribution of water residence times. High speed mapping was particularly useful in understanding the tidally complex area surrounding the EDB, because measurements made over relatively short time scale (hours) over a broad spatial scale (tens of miles) are required to resolve tidally associated changes (flood tide, ebb tide, slack tide). Here, we present preliminary results from our high speed mapping efforts, and discuss how high speed mapping helped to distinguish linkages between physical and biogeochemical processes. We demonstrate how data generated by this approach provide information useful to other monitoring programs, such as existing fixed monitoring stations, discrete sampling programs, and remote sensing efforts.

Keywords: Water quality, nutrients, isotope hydrology, high speed mapping, biogeochemical gradients
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Characterization of the Impacts of the Emergency Drought Barrier on Nutrients and Phytoplankton in the Lower San Joaquin River

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As a result of extreme drought conditions, an emergency drought barrier (EDB) was installed at False River between May and October 2015 to manage saltwater intrusion to the Delta. This action also altered water input to and circulation within Franks Tract. The potential ecological impact of the management action on nutrient concentrations and lower trophic levels in Franks Tract was uncertain however the barriers had the potential to create conditions that support algal blooms and promote harmful algal species. Franks Tract is generally characterized by relatively high water clarity, low inorganic nutrients and low chlorophyll, between 2 and 4 µg/L. Episodes of elevated phytoplankton, with chlorophyll >10 µg/L were documented in Sept 2011 and Oct 2012, dominated by *Microcystis* or a long-chain diatom, suggesting the potential for blooms to establish in the flooded island. We hypothesized that the EDB would alter source water, nutrients, and residence time in Franks Tract, creating favorable conditions for either slow growing *Microcystis* or long chain-forming diatoms. We carried out a series of cruises at stations located in the lower San Joaquin River, Mokelumne River, and Franks Tract between September and November (with the EDB in place and after its removal) and measured nutrients and chlorophyll, primary production and nutrient uptake, and assessed phytoplankton functional groups with diagnostic phytopigments. Nutrients and chlorophyll concentration in Franks Tract were remarkably similar to historical ranges with no clear effect of the EDB. *Microcystis* was noted in low to medium densities throughout the study area. Two remarkable differences in our observations were elevated chlorophyll at locations in the Mokelumne River and dense stands of submerged aquatic vegetation, including *Stuckenia pectinata* and *Potamogeton crispus* within Franks Tract. Our results suggest no large-scale alteration in nutrients or lower trophic levels as a result of the EDB operations.

Keywords: Emergency Drought Barrier, Franks Tract, Microcystis, Nutrients, San Joaquin River
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Effects of the Emergency Drought Barrier on the Transport of Zooplankton to Delta Smelt Habitat

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The dispersive transport mechanisms that move brackish water landward in the western Delta also move freshwater seaward; therefore the rock barrier installed on False River west of Franks Tract in 2015 was expected to reduce dispersive fluxes in both directions. The copepod *Pseudodiaptomus forbesi* is important food for the endangered delta smelt in the low-salinity zone (LSZ) to the west of the rock barrier, but the population is most abundant in freshwater to the east. Therefore the barrier may have reduced transport to delta smelt habitat and thereby reduced abundance. In 2010–2012 we conducted field surveys of copepod abundance and developed a box model to estimate exchange rates among regions of the Delta and to estimate mortality of the life stages of *P. forbesi*. Mortality of nauplii (larvae) in the LSZ was very high and sufficient to eliminate the copepod population there, but was offset by the subsidy of copepods from freshwater. In fall of 2015 we repeated the field surveys to determine copepod distributions, modeled hydrodynamic conditions with and without the barrier, and used the box model to examine how transport changed with installation of the barrier. As expected, tidal exchange between Franks Tract and the LSZ was reduced in 2015. Abundance gradients across the Delta were steeper than those from earlier years, consistent with reduced dispersion (or higher mortality) in the LSZ than in earlier years. This steepening may have offset the reduction in exchange rate due to the barrier, because abundance in the LSZ was not markedly lower than in previous dry years.

Relevance: manipulation of flow patterns in the Delta through alteration of its physical structure can have unintended consequences for species of concern. Plans for such alterations should include investigations into hydrodynamic consequences and how they cascade to ecological responses.

Keywords: Drought barrier, copepod, particle tracking model, hydrodynamics, spatial distributions
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