Before and After: Evaluating Spring Freshwater Inflow Regulations for the San Francisco Bay Estuary

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Fresh water flowing into California's San Francisco Bay Estuary is highly contested and tightly managed. The current regulations for spring inflows were established in 1995, following a severe multi-year drought, lawsuits, fish population declines and several Endangered Species Act listings. These new standards were designed to provide inflows that reflected variation in hydrological conditions, prevent extreme low inflows, and improve low salinity habitat. However, since then, both fish populations and spring inflows (as a percentage of estimated unimpaired inflows) have continued to decline. I investigated the implementation and effects of the 1995 spring inflow standards. I found that, although the standards had been met in most years, they were waived in the two driest years (2014 and 2015) and, based on publicly available flow and EC data, apparently violated in a few other below median hydrology years. Comparison of pre-standard (1970-1994) and post-standard years (1995-2015) showed that implementation of the standards had little effect on seasonal flow amounts, although the frequency of extreme low inflows was reduced. Low salinity habitat quality and quantity showed slight improvement in some dry years, but not in the driest years when the standards were waived. Overall, this analysis suggests that the 1995 flow standards provided little if any improvement in inflow or ecological conditions in the estuary, information that should be informative for the State Water Board's review of the standards that is currently underway.

Keywords: Freshwater inflow, regulations, estuary, habitat, WQCP, SWRCB, spring, X2
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Assessing Functional Flows at a Global Scale: Implications for Environmental Flow Management Strategies in California

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The number of hydropower dams in the world is expected to more than double by 2030, a projection that does not include construction of dams for other purposes like flood protection, water supply, navigation, or recreation. This is one of many factors indicating that river systems throughout the world have been and will continue to be modified through water management practices resulting in impaired flow regimes critical to supporting hydrogeomorphic processes and ecological functionality of riverscapes. A functional flows paradigm – emphasizing process-based hydrograph components – has emerged as a guide for developing environmental flow frameworks in heavily managed river systems. Recent case-studies have explored Mediterranean-montane rivers in the western United States to identify key flow regime components, such as wet-season initiation flows, peak magnitude flows, recession flows, dry-season low flows, and interannual variability. The work presented here expands this framework to identify key hydrograph components in major hydroclimatic regions of the globe. Unimpaired natural flows were used to identify major hydrologic regions with distinct natural flow regimes and corresponding functional flow components specific to biophysical needs. Identification of these functional flow components enables comparison between a Mediterranean-montane river system, such as the Sacramento-San Joaquin, and other hydroclimatic regions. Our global-scale functional flow typology has been developed with an eye toward informing water resource managers on environmental flow requirements in different regions. Results suggest that implementing environmental restoration through establishment of sustainable environmental flows requires distinct policies in different hydro-climatic regions. Furthermore, a global perspective on environmental flows may inform best management practices for California's heavily managed riverscapes.

Keywords: functional flows, environmental flows, water management, flow regime
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Improving Multi-Objective Ecological Flow Management with Flexible Priorities and Turn-Taking: A Case Study from the Sacramento River Basin and San Francisco Bay–Delta Estuary

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Problem: The Sacramento River Bay Delta system is highly regulated to meet the water needs of agriculture, human communities and a range of natural resources that includes endangered Chinook salmon, green sturgeon and Delta smelt. Hydro project and water conveyance operational plans are currently informed by simulation modeling that attempts to globally optimize water allocation over a vast array of location specific objectives.

Approach: We demonstrate an improved method for multiple objective allocation of water: “turn taking” optimization (TTO) within a coupled multi-model cloud computing framework. We apply TTO to an array of physical hydrologic models linked with the Ecological Flows Tool (EFT), a multi-species decision support framework for evaluating how specific components of the flow regimes can be "specialized" to promote and balance favorable habitat conditions for 13 representative species and 31 indicators within the Sacramento River and San Francisco Bay Delta. TTO incorporates the existing water delivery and socio-economic water management criteria, priorities and constraints and optimizes monthly water release patterns each water year using a dynamically shifting set of EFT indicators. As an individual EFT indicator is successful in a particular year, its priority weight in one or more subsequent years is reduced (depending on the life-history needs of each species). Rather than attempting to meet all criteria every year, "turn taking" creates additional flexibility and opportunities for other indicators to be successful in other years.

Results: Evaluating the overall number of EFT indicators that were successful over simulation years by comparing TTO to a business as usual reference case that did not use TTO, revealed 12 EFT indicators that were improved with TTO, 14 which showed no change and 5 which showed a reduction with TTO.

Relevance: TTO provides an innovative new optimization technique to assist water managers balance competing objectives.

Keywords: EFT, optimization, environmental flows, CALSIM, USRDOM, USRWQM, Ecological Flows Tool
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Basin Planning for Coldwater Functional Flows

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Recent drought years have illustrated the shortcomings of the existing water regulations with regards to maintaining environmental functional flows and thermal conditions, particularly related to sustaining critical life stages of threatened and endangered anadromous fish species. Recent work at the State Water Board, as a part of the Bay-Delta basin planning process, has included temperature simulation of environmental flow alternatives for the lower San Joaquin River and its tributaries at various fractions of tributary unimpaired flow. Modeling results are used to show the effectiveness of flow releases in meeting temperature criteria in certain months for spawning, egg viability, rearing, and migration within the Stanislaus, Tuolumne, and Merced Rivers. In addition, the water supply costs of meeting these flow objectives can be demonstrated. The lower San Joaquin and its tributaries can be contrasted with other case studies in the American River, Sacramento River, and Mill Creek. There exists a gap between the annual focus of operational management structures established to implement Biological Opinions and drought emergencies, and long-term basin planning that includes the consideration and implementation of environmental flow objectives. Temperature and water supply modeling tools are useful to demonstrate likely outcomes of planning alternatives, but effective implementation of flow objectives requires evaluation and optimization of the water costs and temperature benefits, among other benefits to listed and other species.

Keywords: Temperature modeling, water supply, anadromous fish, flow objectives, functional flows
Session Title: Ecological Flows and Flood Control
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Flood Control 2.0: Integrating Habitat Restoration into Flood Risk Management at the Bay Interface

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Throughout the San Francisco Bay region, flood control channels at the Bay margin are aging and in need of replacement. Many of these channels do not pass flood waters and sediment loads effectively because they were designed decades ago when watersheds were less developed and the Bay elevation was lower. In addition, the building of these channels often resulted in the fragmentation, disturbance, or complete destruction of important bayland habitats as well as disruption of the physical processes that maintained these habitats over time. Flood control managers currently have a rare opportunity to redesign new flood control projects at the Bay margin that can help meet current and future flood control needs and improve bayland habitat conditions, provided they have the right tools and knowledge base to develop resilient, multi-benefit designs.

Flood Control 2.0 is an EPA-funded project involving several agency partners that is aimed at developing tools and providing information that can be used in designing multi-benefit flood control channels at the Bay margin. This presentation will provide an overview of work being done under Flood Control 2.0 to characterize key landscape features and sediment delivery characteristics of major flood control channels, and develop high level management concepts that could support flood risk management while supplying freshwater and sediment to existing and restored baylands habitats. In the coming decades, reconnecting flood control channels with adjacent tidal areas will be essential for protecting people and ensuring bayland habitats are able to keep pace with an increasing Bay water surface elevation.

Keywords: Flood risk management, Multi-benefit management, Bayland restoration, Sediment delivery
Session Title: Ecological Flows and Flood Control
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