McCormack-Williamson Tract Research Project Overview

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With restoration of the McCormack-Williamson Tract (MWT), in the North East Delta, highlighted in multiple management plans for both flood protection and ecosystem benefits, quantifying changes with restoration will benefit future restoration actions throughout the Delta. Integration across fields of study in a large spatial scale is necessary to better understand what processes, both physical and ecological, determine the success of restoration actions. The goal of this project is to collect data prior to restoration in order to obtain baseline information in which to compare to a restored state. We have been collecting water quality, lower trophic food web community, isotopes to describe the isoscape, and constructing a hydrodynamic model to test future hydrodynamic and ecological scenarios. This interdisciplinary approach allows for an integrated dataset where the various disciplines can help to explain findings. On February 11, 2017, MWT levees breached during a winter flooding event and remained connected to the river for 108 days until levees were repaired. This unplanned flooding allowed for a "preview" of a future restored state of MWT. Following the levee breaching, the research team was able to begin sampling within and around the tract for water quality and lower trophic levels. The flooding also allowed for the collection of water stage data that will help to inform the hydrodynamic model. The rare opportunity to preview a large-scale restoration has provided valuable insight and has helped to guide future research questions and monitoring objectives. Additionally, incorporating information from long-term monitoring upstream in the Cosumnes River allows for a better understanding of ecosystem function at the landscape scale.

Keywords: Monitoring, Restoration, Food Web, Isotopes, Hydodynamic Model, Interdisciplinary, Water Quality

Poster Cluster Title: McCormack-Williamson Tract Monitoring and Restoration Preview

Flooding of McCormack-Williamson Tract Creates High Zooplankton Biomass, a Distinct Zooplankton Community, and Subsidizes Downstream Habitat.

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The restoration of marsh and intertidal habitat in the Delta aims to provide productive high quality habitat to native species. Additionally, restoration actions can influence the productivity of surrounding habitats. In February of 2017, the McCormack-Williamson Tract flooded due to high flows from the upstream Cosumnes River. This unintentional flooding allowed for a four-month experiment to observe food web and zooplankton community structure on the Tract and how outflows influence downstream productivity and zooplankton community assemblage. Sampling occurred weekly on the Tract and monthly in surrounding habitats. The Tract was a highly productive habitat during inundation, supporting a community of high value food resources such as *Daphnia pulex*, a large bodied cladoceran, which made up most of the zooplankton biomass. Additionally, hydrologic conditions increased productivity relative to adjacent habitats. Cluster analysis of Bray-Curtis dissimilarity of the zooplankton community clustered Tract and downstream habitats indicating a high degree of community similarity and that outflows influenced downstream community structure. During inundation, the McCormack-Williamson Tract provided a productive habitat with a unique zooplankton community. Furthermore, it is likely that the Tract's productivity was exported, increasing available food resources to higher trophic levels in downstream habitats.

Keywords: restoration, zooplankton, productivity, subsidy

Poster Cluster Title: McCormack-Williamson Tract Monitoring and Restoration Preview

High Frequency Monitoring of Isotopic Signatures in the Flooded McCormack-Williamson Tract Elucidates the Effect of Restoring Floodplain Habitat in the Sacramento-San Joaquin Delta

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Increasing the quality and quantity of habitat for native species in the Sacramento-San Joaquin Delta is a high priority for California water managers. The McCormack-Williamson Tract (MWT) levee failure of February 11, 2017, was embedded within the wettest year of record for the Mokelumne-Cosumnes river system and thus provided a unique opportunity to examine the potential trajectory of future restoration actions within the Delta. We carried out high frequency sampling (n=32, 13% of days) of suspended particulate organic matter (SPOM) and waters in the Mokelumne and Cosumnes river systems, including nearby sloughs, and the post-failure, flooded interior of MWT. Carbon ($\delta^{13}C$) and nitrogen ($\delta^{15}N$) isotopes in SPOM and $\delta^{2}H$ and $\delta^{18}O$ of waters were analyzed and *in situ* water quality data were collected in tandem, to contextualize isotopic data. Sampling was confined to an 8 km^2 region surrounding MWT (6.7 km^2 interior). This unintentional flooding provided a natural before-after-control-impact experiment to study the effect that sudden inundation of a Delta island at this elevation can have on food web development and ecosystem function. Source waters were isotopically distinct ($p<.01$), and co-varied along the Global Meteoric Water Line ($R^2>0.99$), providing a semi-conservative tracer of mixing. The $\delta^{13}C$ values of SPOM varied between -37.3 and -23.9‰ and were significantly more negative on the flooded island by 1.2‰, $p<.01$. Potentially due to increased recycling of organic carbon concomitant with accelerated ecosystem metabolism. Concurrently, $\delta^{15}N$ values varied between 1.0 and 12.4‰ and were not significantly different between riverine and flooded island sites. Our data indicate that over short periods of flood inundation (13 weeks) new freshwater habitats exhibit higher productivity than their riverine counterparts and could therefore increase organic matter subsidies to downstream ecosystems. In turn, elevated autochthonous contributions to the food web could support rearing native fish populations by enhancing zooplankton communities.

Student Award Competition: Yes

Keywords: Stable Isotopes, Floodplain, Restoration, Flooding, Levee, Productivity, Fishes, SPOM, Delta

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Hydrodynamic and Water Quality Model of the McCormack-Williamson Tract

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As a part of an interdisciplinary team looking to evaluate the efficacy of an intertidal and floodplain restoration project on the McCormack Williamson Tract (MWT), a hydrodynamic model is being developed. The model is a two-dimensional hydrodynamic model using Deltares Delft3D Flexible Mesh Suite. The model uses an unstructured orthogonal grid and solves both a depth-averaged continuity equation and the full momentum equations. We created the model in order to evaluate the dynamics of the aquatic habitat around the Tract, how proposed restoration alternatives would affect the existing habitat, and to see how various sea level rise and other climate change scenarios would affect the alternatives. We will expand upon the model in order to evaluate water quality as well. With these tools, we can evaluate the transport of nutrients, temperature, and salinity as well as phytoplankton using the Deltares DELWAQ engine, which couples with the hydrodynamic model and ecological data that is being collected.

In order to calibrate the model and provide further insight, we have deployed several pressure transducers in order to gather observed stage data in various locations around the tract and collected water quality data in the study area. During this year's flood season, the Tract's levees were breached which inundated MWT. This opportunity allowed for the deployment of two pressure transducers and a dissolved oxygen meter inside of the flooded tract, as well as extend our water quality monitoring within the flooded Tract. These field data in conjunction with the models will allow us to critically evaluate the long-term hydraulic and ecologic effects of intertidal wetland restoration within the Delta.

Student Award Competition: Yes

Keywords: hydrodynamic modeling, water quality modeling, habitat restoration, McCormack-Williamson Tract

Poster Cluster Title: McCormack-Williamson Tract Monitoring and Restoration Preview

Hydrospatial Analysis for Evaluating Floodplain Restoration: Application to Sacramento Splittail Habitat on the Lower Cosumnes River, California

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Dynamic interactions between rivers and floodplains drive freshwater ecosystems. In highly modified riverine landscapes, these interactions are reduced and homogenized in space and time. Enhancing river-floodplain connectivity is a common restoration objective, but it is often difficult to determine how various actions, such as levee setbacks or environmental flow releases, will impact physical conditions relevant to ecological functions, such as depth, velocity, duration, timing, and connectivity. Understanding changes to these complex interactions requires improved quantification of spatio-temporal variability of floodplain inundation patterns, or the hydrospatial regime. The research presented here quantifies the hydrospatial regime of a floodplain along the lower Cosumnes River, California, both before and after restoration, and uses this to evaluate changes to Sacramento splittail habitat availability. This approach summarizes physical metrics based on spatially-distributed depth and velocity, derived from 2D hydrodynamic modeling for pre- and post-restoration conditions, at daily time steps for the 100-year-plus flow record of the largely unregulated Cosumnes River. This hydrospatial analysis is then applied to splittail habitat suitability curves, allowing for high-resolution quantification and identification where and when particular floodplain conditions are suitable for life-history needs. This approach is amenable to evaluating changes due to restoration, as changes in mean conditions and variability due to restoration are not consistent across all metrics or floods and may depend on landscape position. For splittail habitat suitability, we found that overall weighted usable area nearly doubles post-restoration; however, there is substantial variability within and across years and across the floodplain. This research refines expectations for restoration, while providing tools to compare relative benefits of flow prescriptions and habitat restoration actions. Hydrospatial analysis quantifies how changes vary over space and time and thus supports management and restoration of floodplains for variable conditions that benefit species, such as splittail, and their ecosystems.

Student Award Competition: Yes

Keywords: flood regime, floodplain restoration, modeling, spatial analysis, habitat, Cosumnes River

Poster Cluster Title: McCormack-Williamson Tract Monitoring and Restoration Preview