

Hydrodynamics and Sediment Transport of the Tidally Influenced James River, VA

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Introduction

- The James River runs 560 kilometers across the state of Virginia before entering the southern Chesapeake Bay, near the mouth, where the Bay meets the Atlantic Ocean.
- From the lowermost dam near Richmond, VA to the Chesapeake Bay, the water level and velocity of the James River are primarily influenced by the tidal processes, but experience occasional periods of non-reversing flow associated with specific meteorologic events.

Methods

- From Oct 2018 – Nov 2019, hydrodynamic and sediment data were collected using an instrument package deployed in the James River, VA.
- In June 2022 and March 2023, I redeployed an acoustic doppler current profiler (ADCP) in the same location. During deployments, a ship-mounted ADCP was used to measure water velocity at multiple tidal stages.
- CTD and optical backscatter casts were performed across the ADCP transect and along a roughly 5 km stretch of river including either side of the estimated reach of saltwater.

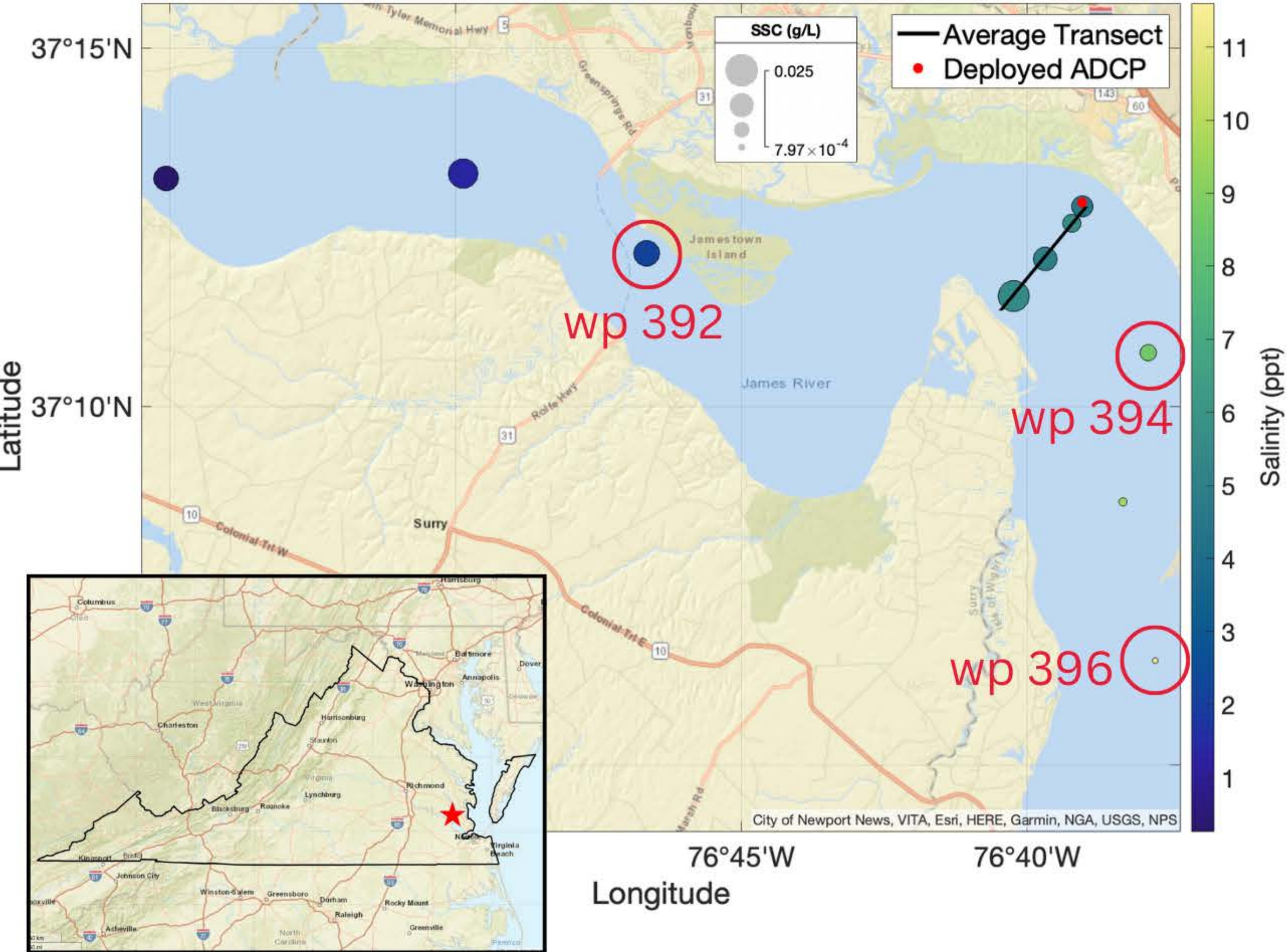


Figure 1. Location of data collection with SSC and salinity data represented. Three waypoints are highlighted and the casts are represented in Figure 3.

Higher SSC is generally associated with lower salinity

Results

Inner and outer bends of the channel correspond to the flood and ebb-dominated directions of tidal flow

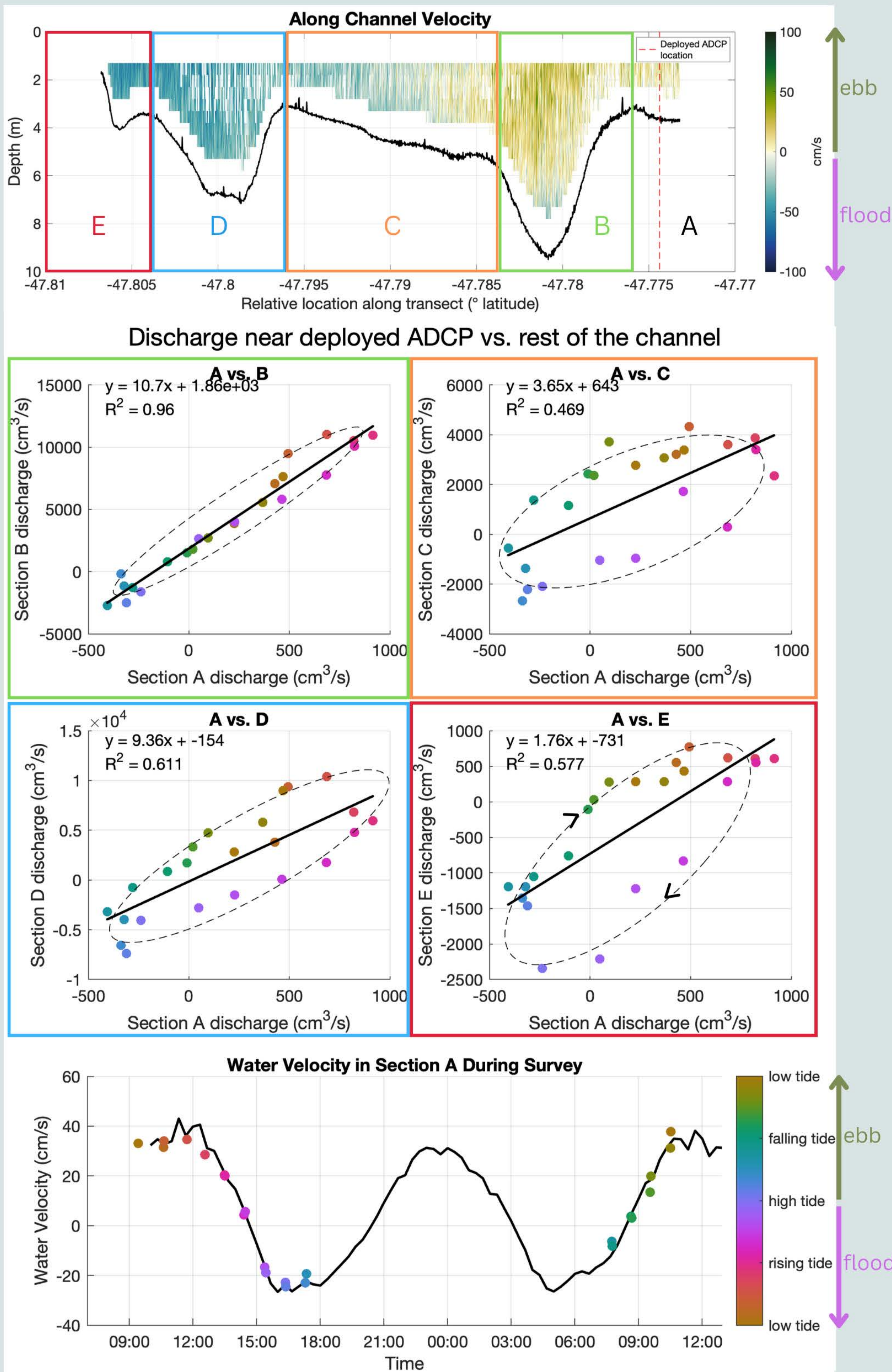


Figure 2. Depth averaged velocity in section near the deployed ADCP vs. sections spanning the width of the channel, as well as water velocity during the survey to show tidal stage at time data collection.

Discussion

- I have identified a hysteresis in the cross-channel data, demonstrating that the inner and outer bends of the channel correspond to the flood and ebb-dominated directions of tidal flow (Figure 2).
- Based on spatial CTD and SSC data, there is apparent sediment trapping associated with the salinity gradient (Figure 1).
- Saltwater reaches further upstream in the spring than in the summer. There also is an associated peak in SSC (Figure 3).

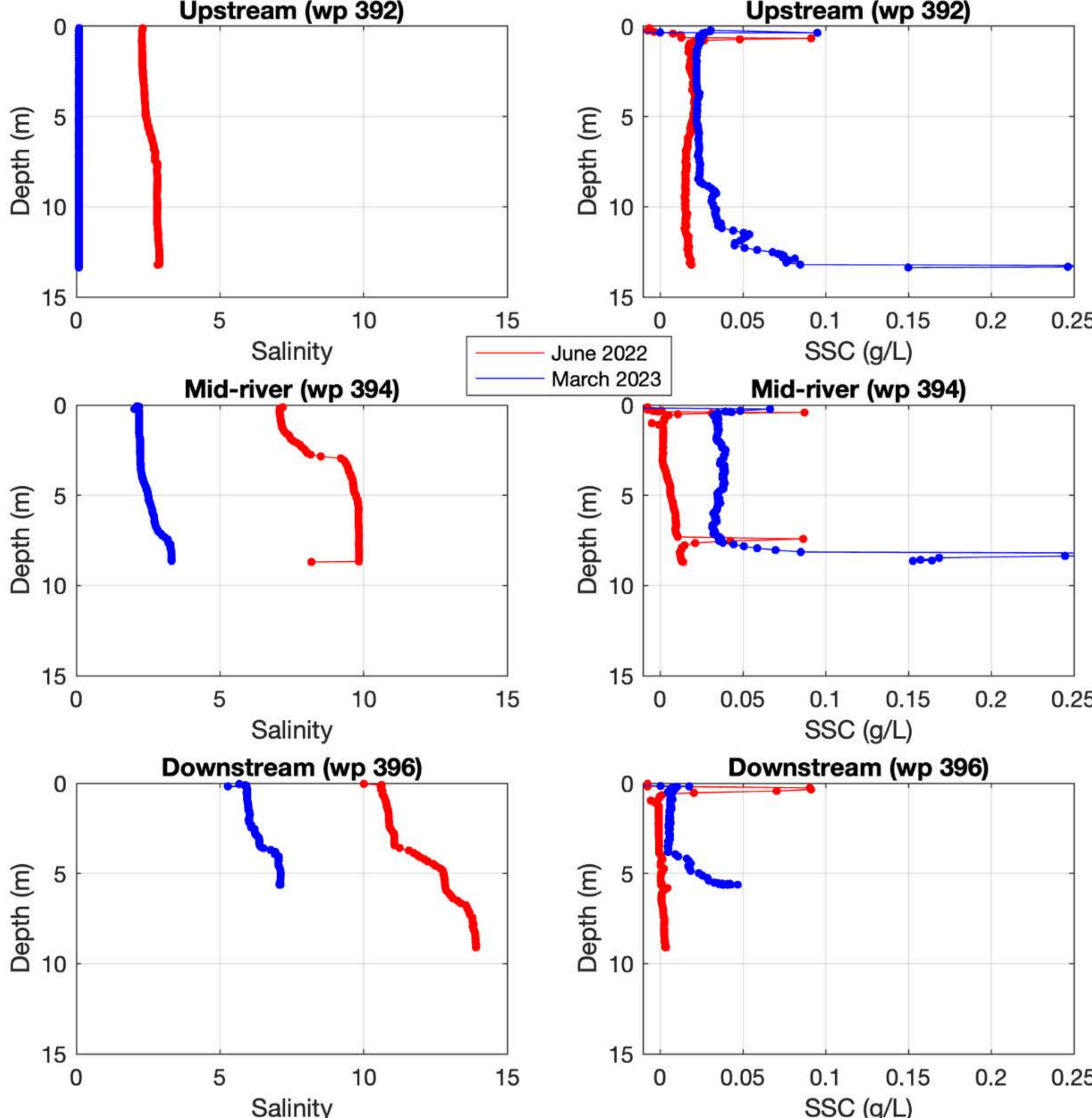


Figure 3. Salinity and SSC in the summer (June 2022) and spring (March 2023) at three waypoints that are highlighted on Figure 1.

Future Directions

- These data allow for the calculation of sediment flux under a variety of discharge and tidal conditions, and will be used to determine the river's role as a sediment sink or source.
- There are periods of time when the direction of flow doesn't reverse during high tide. I plan to assess the sediment flux associated with these flushing events.

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