



# Cross-Channel Assessment of Severn River Watershed Observatory Current and Water Quality Data Using Unmanned and Autonomous Platforms



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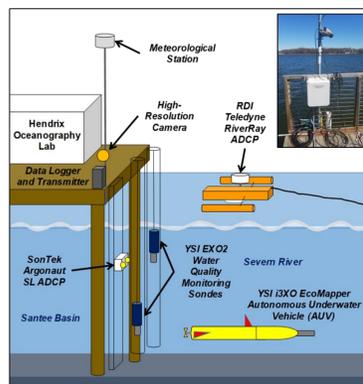
## Abstract

The Severn River Watershed Observatory (SRWO) is an estuarine observation and monitoring network deployed to characterize the physical, chemical, biological, acoustic, and optical properties of the lower Severn River. In this study, a towed Acoustic Doppler Current Profiler (ADCP) and an Autonomous Underwater Vehicle (AUV) equipped with water quality sensors were used to determine whether continuous water quality and current data collected by SRWO is representative of cross-channel conditions at the mouth of the lower Severn River.

## Study Area and Methods



**Figure 1.** Map of the lower Severn River study area showing locations for U.S. Naval Academy (USNA), Severn River Watershed Observatory (SRWO) Node 1 and Node 2. Also shown is the general cross-channel track for EcoMapper AUV missions and RiverRay ADCP tows used in this study.



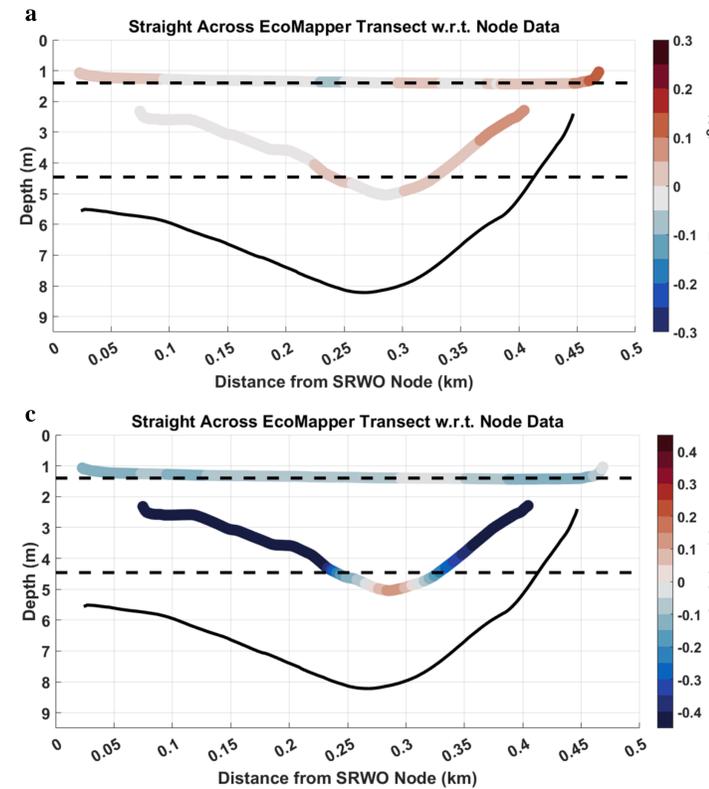
**Figure 2.** Conceptual Diagram of SRWO Node 1 and deployment plan for the EcoMapper AUV and RiverRay ADCP.

Node 1 of the SRWO is located at the USNA Hendrix Oceanography Lab (Fig. 1). It consists of a data logger and transmitter, a meteorological station, a high-resolution camera, a SonTek Argonaut (side-look) SL ADCP, and YSI EXO2 water quality monitoring sondes mounted to collect data every 15-minutes on parameters at the surface (~1-1.5 m) and bottom (3.5-4.5 m) of the lower Severn River water column (Fig. 2). In February 2019 a towed RiverRay ADCP and an EcoMapper (AUV) deployed on autonomous missions were used to evaluate whether current and water quality data (Temperature, Salinity, Dissolved Oxygen, Turbidity) collected by SRWO Node 1 is representative of cross-channel conditions at the mouth of the lower Severn River (Fig. 3).

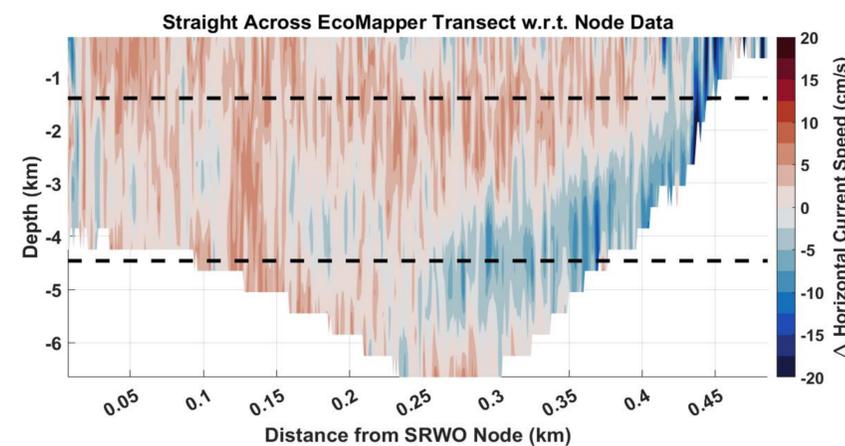
**Figure 3.** (a) MIDN 1/C Kristy Lehmer reviewing RiverRay ADCP data and plotting transects for an EcoMapper AUV mission and (b) MIDN 1/C Matt Spelich sending the EcoMapper AUV on a cross-channel mission in the Severn River on February 22, 2019.



## Results and Discussion



**Figure 4.** Cross-channel contour plots of differences in (a) Temperature (°C); (b) Salinity; (c) Dissolved Oxygen (ODO, mg/L) and (d) Turbidity (NTU) measured by the surface and bottom YSI EXO2 sondes at SRWO Node 1 and the same parameters measured *in situ* by an EcoMapper AUV running fixed depth autonomous missions across the channel of the lower Severn River on 15 and 22 February 2019. All differences are expressed as  $\Delta(\text{parameter}) = \text{SRWO Node 1 (parameter)} - \text{EcoMapper (parameter)}$ . All plots are referenced from SRWO Node 1 (Fig. 1). Black dashed lines indicate depths of YSI EXO2 sondes at SRWO Node 1. Color contour line is smoothed (60 second moving window) data collected along the autonomous track of the EcoMapper AUV.



**Figure 5.** Cross-channel contour plot of differences between horizontal current velocity magnitudes (speed) measured at SRWO Node 1 and 0.25 m depth-binned, averaged (4 tows, 1 m interval) horizontal current speed measured by the RiverRay ADCP on 08 February 2019 ( $\Delta(\text{cm/s}) = \text{SRWO Node 1 SonTek Argonaut SL ADCP (cm/s)} - \text{RiverRay ADCP (cm/s)}$ ). Plot is referenced from SRWO Node 1 (Fig. 1).

*In situ* temperature (Fig. 4a), salinity (Fig. 4b), dissolved oxygen (Fig. 4c), and turbidity (Fig. 4d) data collected by the EcoMapper AUV during fixed-depth (1-1.5 m from surface), cross-channel autonomous missions in February 2019 showed that data collected by the SRWO Node 1 surface (~1.5 m) water quality sonde was generally representative of cross-channel conditions in surface waters of the lower Severn River. Data collected by the EcoMapper AUV during fixed-depth (1-2 m off bottom), cross-channel autonomous missions in February 2019 showed temperature and salinity data collected by the SRWO Node 1 bottom (~4.5 m) water quality sonde (Fig. 4a & b) was generally representative of cross-channel conditions in bottom waters of the lower Severn River but dissolved oxygen and turbidity data collected by the SRWO Node 1 bottom sonde was far less representative, especially in the deeper sections mid-channel (Fig. 4c & d). These results support that SRWO Node 1 is doing an adequate job of collecting water quality data representative of surface waters of the lower Severn River but also suggests a need for additional seasonal comparisons and more, robust AUV survey missions to better assess how well SRWO water quality data represents conditions in the bottom waters of the lower Severn River.

Comparisons of 0.25 m depth-binned, averaged horizontal current magnitudes measured during RiverRay ADCP tows on 08 February 2019 to 15 minute averaged horizontal current magnitudes measured at SRWO Node 1 during the time of tow revealed significant differences (+/- 5-10 cm/s) between horizontal current magnitudes measured at SRWO Node 1 and depth-specific horizontal current magnitudes across the length of the main channel of the Severn River (Fig. 5). Comparisons of SRWO Node 1 and RiverRay ADCP data revealed a compass interference on the SonTek Argonaut SL ADCP at SRWO Node 1 so no comparison of current direction, depth-integrated streamwise flow or transverse flow was made during this study. Such comparisons should be made after the compass error is corrected.

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## Conclusions

- *Autonomous underwater vehicles like the EcoMapper AUV and unmanned platforms like the RiverRay ADCP provide a means to "fill the gaps" in data provided by fixed monitoring stations like the SRWO*
- *Future efforts should focus on seasonal comparisons and more, robust AUV survey missions to better assess how well SRWO water quality data represents conditions in the lower Severn River*