Dissolved organic carbon conditions across the stream-groundwater interface of a third-order river network

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1. Introduction

Dissolved organic carbon (DOC), typically the major form of organic carbon (C) in streams, plays several critical roles in stream C cycling. DOC produces CO_2 when mineralized, fuels stream metabolism, and regulates additional biogeochemical cycles (e.g., nitrogen transformations, trace metal complexation)[1]. Despite its importance, the mechanisms of in-stream DOC processing, remain poorly understood. The stream-groundwater interface (i.e. hyporheic zone, HZ) may be a significant processor of stream DOC due to its rich biological, chemical, and hydrological diversity. While consistent patterns in DOC quantity (i.e. concentration, [DOC]) have been documented along individual hyporheic flowpaths[2,3], few studies have thoroughly characterized changes in DOC quality. DOC quality is a critical parameter that must be included in DOC studies as the quality of DOC impacts its bioavailability, which ultimately affects downstream ecosystems and water quality.

2. Objective & Hypothesis

Central Research Question: Is the HZ a significant processor of stream DOC?

Hypotheses: If the HZ is a significant processor of stream DOC, then:
1) the variance in DOC quantity and quality will be greatest in the HZ when compared to stream water (SW) and groundwater (GW) and
2) microbial processing in the HZ will reduce DOC quantity and quality in the HZ.

3. Methods

1. Study Site

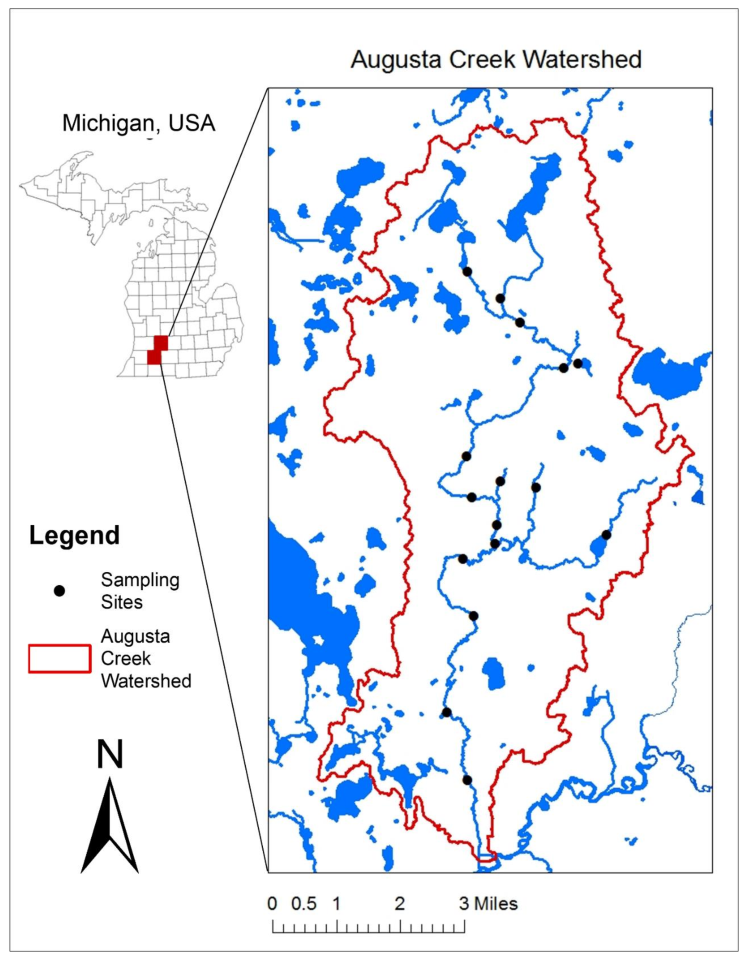


Figure 1: A HZ synoptic sampling campaign was conducted at 16 sites across the third-order watershed of Augusta Creek.

2. Field Setup

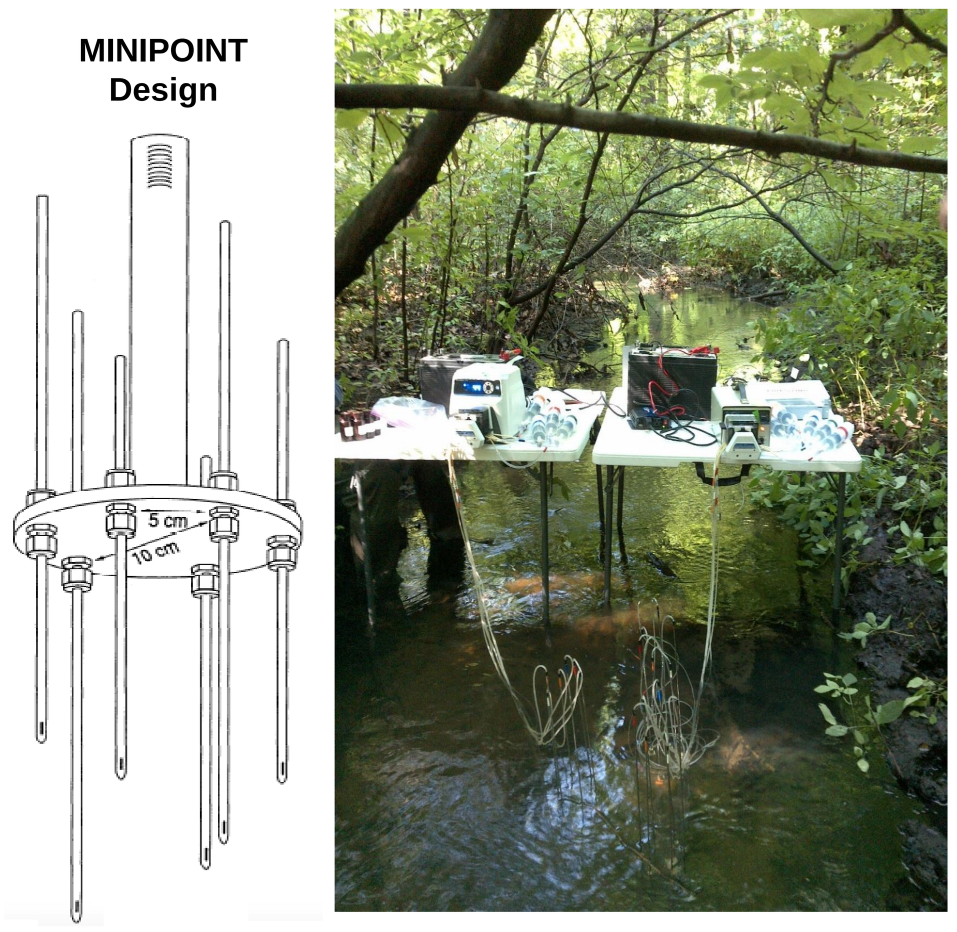


Figure 2: Synoptic sampling field setup. 3 MINIPOINTs were deployed at each of the 16 sites for porewater sampling (Design from Duff et al., 1998).

3. Sampling Scheme & Data Analysis

- Samples were analyzed for [DOC] and specific ultra-violet absorbance at 254 nm (i.e. $SUVA_{254}$). $SUVA_{254}$ is used to infer quality as it is positively correlated with DOC aromaticity[5].

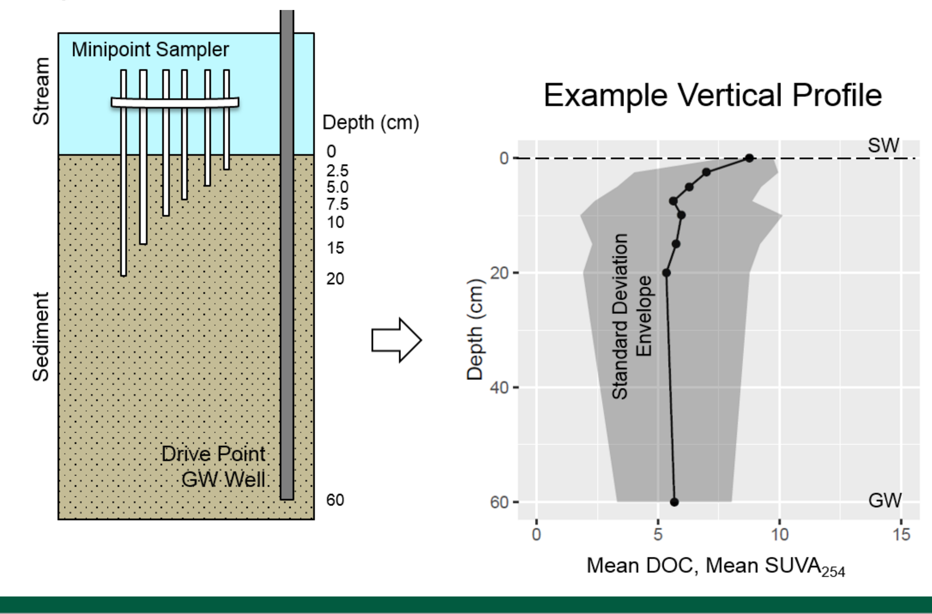


Figure 3: Vertical profiles of [DOC] and $SUVA_{254}$ were constructed and used to assess the hypotheses.

4. Results & Discussion

Initial Results

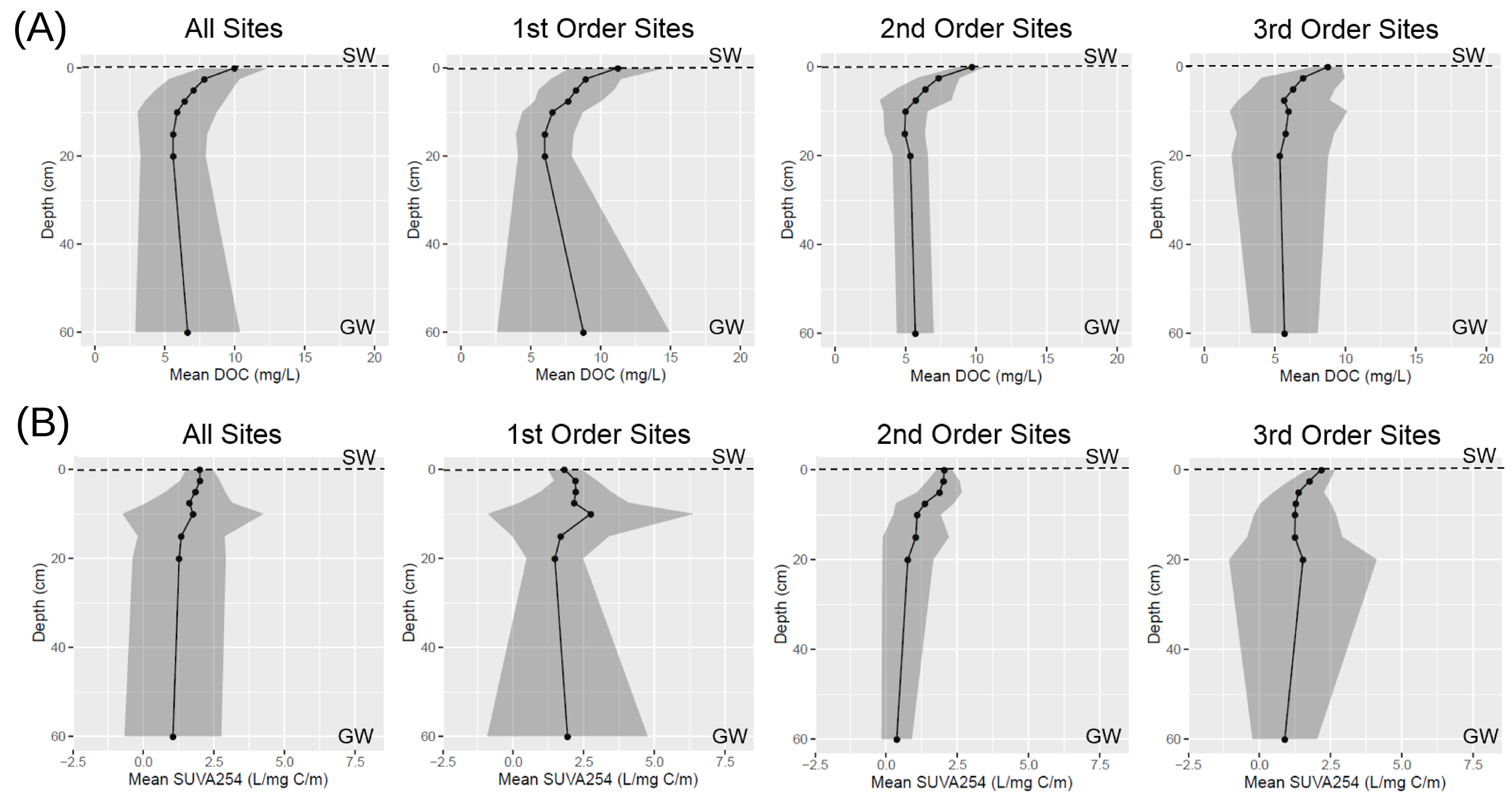


Figure 4: Vertical profiles of A) mean [DOC] and B) mean $SUVA_{254}$ of all 16 sites and by stream order. Each plot includes a standard deviation envelope; n=16 for "all sites", n=6 for "1st order sites", n=5 for "2nd order sites" and n=5 for "3rd order sites."

- Across the watershed, [DOC] and $SUVA_{254}$ decrease with depth, while standard deviation increases over HZ depths.
- *However, GW also exhibits a large standard deviation (e.g.,1st Order Sites), indicative of the important role that regional GW (with variable chemistry) plays in Augusta Creek.*

Advective HZ (AHZ) Model & Results

- To remove the GW signal from our HZ data, chloride profiles (plus temperature data) were used to separate the AHZ from GW (Fig 5C).

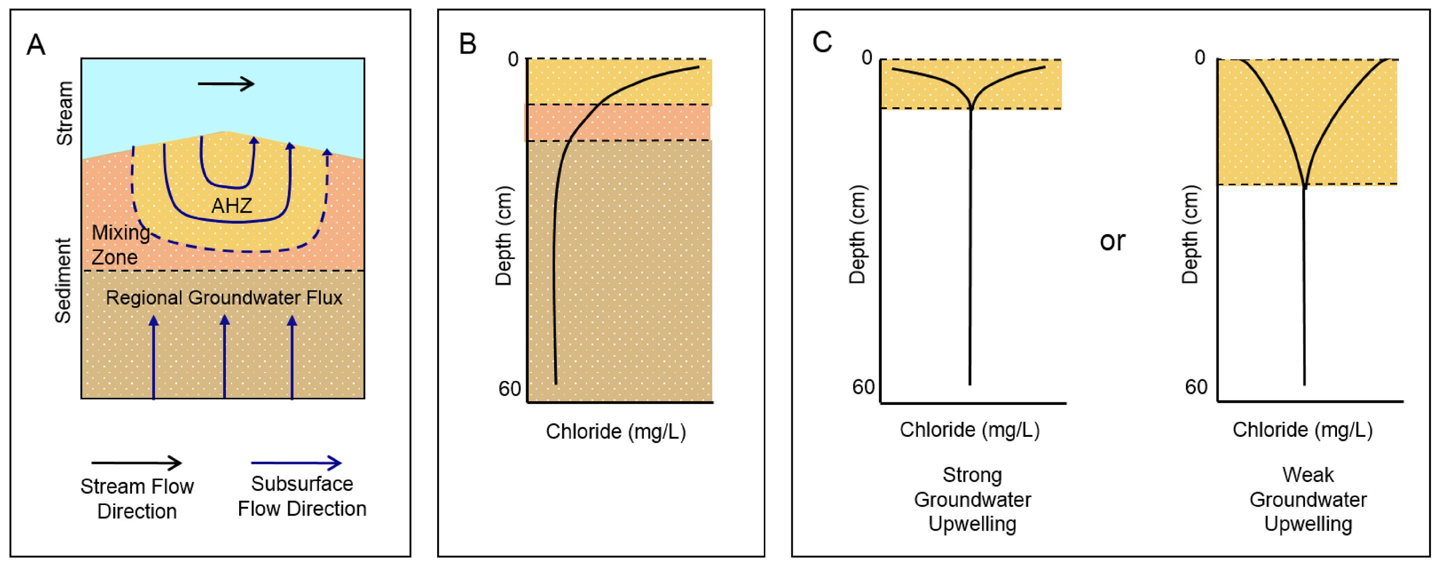
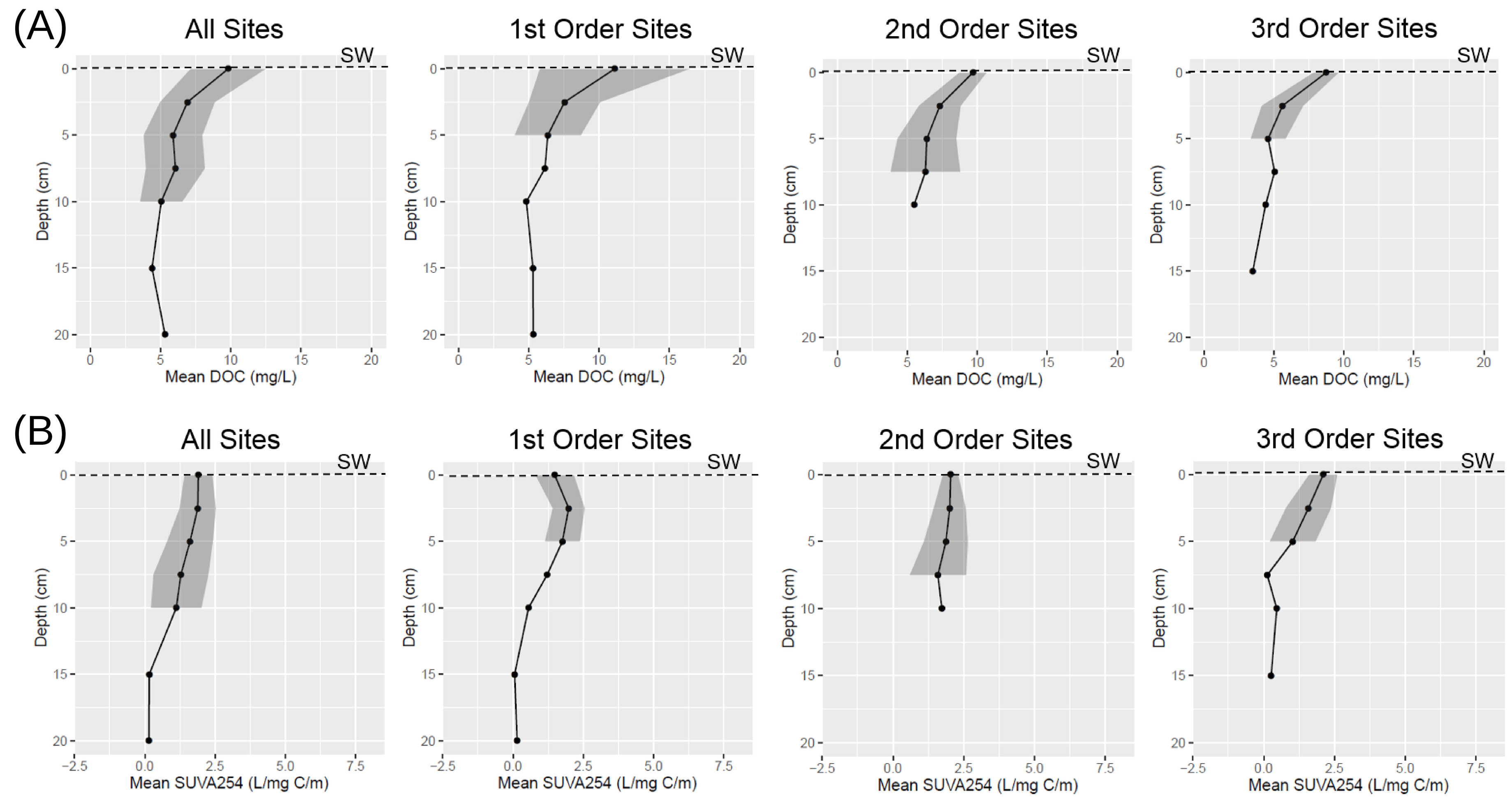


Figure 5: A) Model of SW-GW interactions in a stream bedform, B) the resulting chloride trend with depth and C) changes in trends with varying GW flux.



- [DOC] and $SUVA_{254}$ still show decreasing trends with depth after removal of the GW signal.
- The AHZ is deeper in the steep headwater streams and becomes shallower downstream.

Figure 6: Vertical profiles of A) mean [DOC] and B) mean $SUVA_{254}$ including only AHZ depths. The standard deviation envelope was constructed for all depths where n $\geq$ 3.

5. Conclusions & Future Work

We observed that [DOC] and $SUVA_{254}$ decrease with depth through the HZ, suggestive of microbially-driven DOC transformations. With the support of a KBS LTER Summer Research Fellowship a second synoptic sampling event was conducted during August 2016 to better quantify the GW signal and to observe temporal trends in [DOC] and $SUVA_{254}$. Results to be presented at SFS 2017.

6. Acknowledgments & References

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