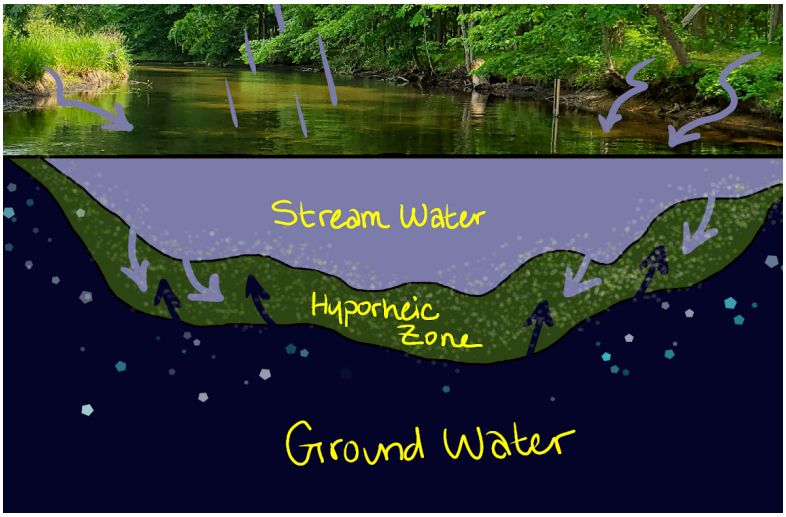
Bonnie Lord

FURSCA 2023 End of Summer Report
Surveying the Reactivity of Dissolved Organic Carbon with the Stream-Groundwater Interface of the Kalamazoo River

Introduction

This summer, I worked with my advisor, Dr. Joe Lee-Cullin, to continue research on a topic previous students had begun, but not fully accomplished. Their work, also through the FURSCA program, had worked to build a greater understanding of dissolved organic carbon as a landscape contribution to the Kalamazoo River, and had focused on simulating the reactions of interest in the lab. My project, in turn, was meant to continue this work *within the actual environment,* essentially asking what kind of results we would get by running similar experiments in the Kalamazoo River itself.

Albion College is an urban landscape - and the changing of the environment from natural landscapes to non-porous and engineered surfaces like concrete, asphalt, and storm drains, has an effect on the way our landscape contributes to the river. Albion College is within the Kalamazoo River watershed, and as water drains to the river, it contributes certain materials and chemicals on its path. One of these, and perhaps the most abundant example, is dissolved organic carbon. Carbon is stored in plants as organic matter such as leaves, grass, and bark, and as water interacts with and breaks down these materials on our streets and within our storm drains, it carries the dissolved carbon cocktail to the river, which then interacts with the environment of the river. Our goal with this project was to investigate how different types of dissolved organic carbon from throughout the watershed interact with one of the most bioreactive and least understood parts of the river: the hyporheic zone.



This is essentially the mixing point of stream and groundwater in the 10-20 cm deep band of sediment lining the bottom of the stream channel, and it harbors a dense microbial community, as well as many of the chemical and physical processes that characterize the river. In this figure, I represent this reactivity as a glitter effect.

To do this, we planned to conduct push-pull experiments in the subsurface of the Kalamazoo River. This is to say that we created a solution of a reactive dissolved organic carbon "leaf tea," a conservative food-grade salt tracer, and stream water, which we then injected into the stream bed (the push phase). We then pulled samples from the sites periodically, and

measured what remained of the initial injectate (The pull phase). From this, we can understand more about how the environment reacts with and disperses the types of chemical contributions the landscape makes to the river. We originally hoped to conduct an experiment for 4-8 dissolved organic carbon types at 3-4 sites in the northern branch of the Kalamazoo River. Though we were not able to fulfill this goal in its entirety in the eight weeks of the project, we were able to achieve many of the objectives of the project.

Results

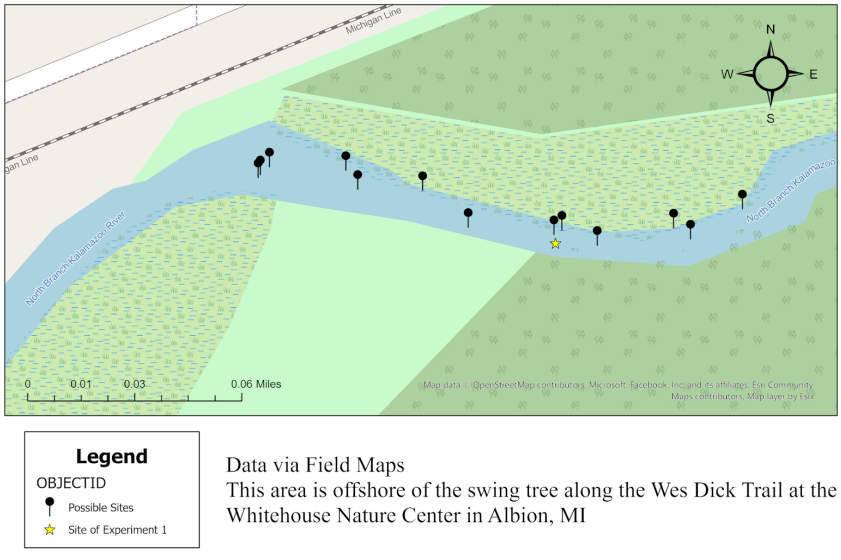
One of the first goals we had for this project was to build my understanding of hydrology and field work as a whole, something we worked on throughout the eight weeks through literature review. I read a wide variety of papers and articles on the qualities and properties of stream beds, as well as papers on the experiment methods and options on how to actually conduct the experiments themselves. As my understanding of the science developed, I was able to develop detailed methods for our experiments, write procedures for the machines we used to analyze our samples, and create conceptual materials like the figure above. Thus, I find myself a much more developed scientist in the basic practices and understanding of the concepts of hydrology.

Much of this work was concentrated in the first few weeks of the project, though I continued to work in this capacity as the project continued. Beyond these academic efforts, lab work played a large role in the project as well. This included calibration of the TOC-L, IC, and oxygen and temperature probes, and the Masterflex L/S pump before they could be applied in the field. This process was something of a learning experience - and caused many of the changes to our timeline that prevented us from conducting more experiments in the field. However, this was something we expected, and though it was frustrating, the troubleshooting and problem solving necessary to progress was valuable to take part in. Ultimately, I believe this process has made me a better scientist and student, especially with the one-on-one advising and assistance of Dr. Lee-Cullin.

When we did finally foray into the field, we were able to conduct six experiments at a site in the Kalamazoo River. Though the first push-pull test proved to be something more of a test-run for our methods, we were able to refine the experiment for our second attempt before continuing with the other types of dissolved organic carbon. After analysis,

Site Selection May 24, 2023 in the North Branch of the Kalamazoo River

Map by Bonnie Lord

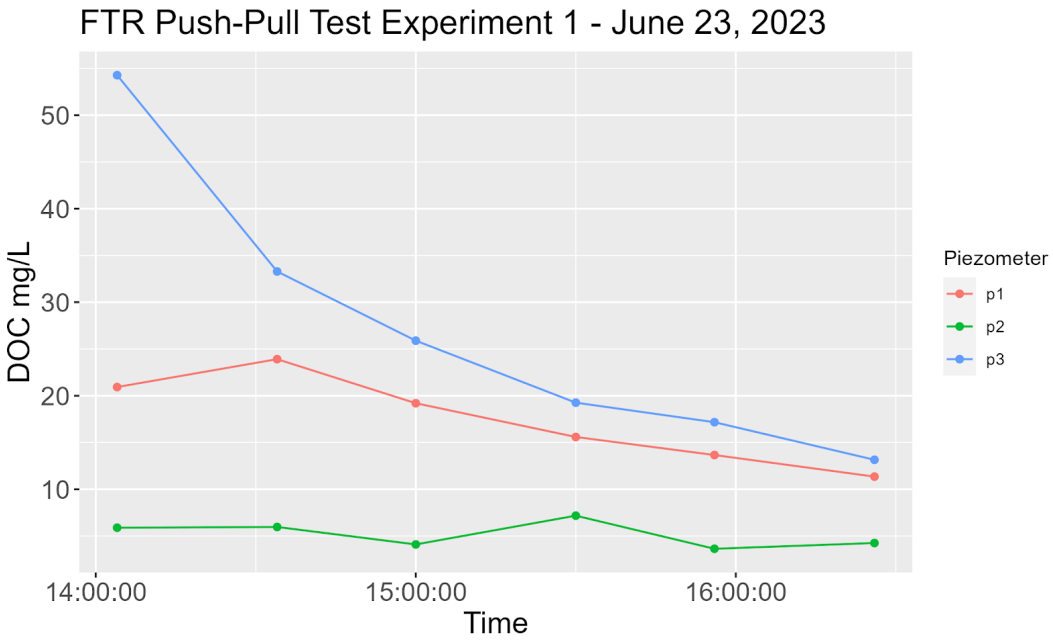


Data via Field Maps
This area is offshore of the swing tree along the Wes Dick Trail at the Whitehouse Nature Center in Albion, MI

our results displayed a pattern of degradation characteristic of the process we are investigating. Though we didn't have time to complete the experiments at another site, we were able to achieve an interesting profile of results from the site we used, and the possibility of future experiments still stands after the completion of this program.

On a personal note, working in the field was a truly engaging and motivating experience. On the left is a picture of me wringing out my feet after topping my waders during experiment one - which I've been told is a rite of passage (Though unintentional). My hope is to spend more time in the field through this project and through future research, though hopefully not nearly as soaked. One of the most important lessons I've learned over my summer FURSCA project is that field work is messy - there are too many variables to be able to control the process as well as any good scientist would prefer, and by using the environment as a lab, one invites variation. Whether it will enhance the experiment or derail it, is another question entirely. We could not predict that the air quality resulting from the Canada fires would prevent us from a week of field work, for example, and all we could do was adjust our goals and pivot to another, indoor aspect of the work, which required just as much patience.

Another goal we had for this work was for me to be able to model the results using the coding language R - something I had never worked with before. Though this proved to be a struggle all of its own, I was able to learn enough to create some representative graphs of our results. This graph, for example, shows the blue line (p3) with the breakthrough curve we expect.



Conclusions

This project, with all of its complications and roadblocks, was able to accomplish plenty of field work and data collection, and the result has implications for our understanding of landscape contributions to the Kalamazoo River, including from Albion College's campus. Streams are not a pipe - they are integrated within the landscape, and the more we know about concepts such as the reactivity of dissolved organic carbon with the hyporheic zone, the more we can accomplish in the way of stream restoration. These chemical processes are integral to the environment, and must be understood if they are to be protected and restored.

With this in mind, I plan to present our findings at the 2023 Geological Society of America in the Fall, and at the 2024 Elkin Isaac Research Symposium in the Spring. Beyond that, I hope to continue doing research through programs like FURSCA and build on the skills and understanding I have gained from this invaluable experience - working towards an education beyond Albion College and a career where I can have a further impact on the world through natural science.

All of this being said, none of this would have been possible without the support of the Russell Bradshaw Endowed Research Fund. Work like this is feasible because of this generosity, and I am extremely grateful for the chance to use the knowledge I have gained to make the world a better place. If the in-depth explanation of the science portion of this project is any indicator, I'm immensely passionate about environmental science, and I hope that any understanding you have gleaned from reading this report inspires you, too.

With deepest gratitude,
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