WWU IWS Internship

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COLLEGE OF THE ENVIRONMENT

WESTERN WASHINGTON UNIVERSITY

MAKE WAVES.

Internship Title:

Organization Worked For:

Student Name:

Internship Dates:

Faculty Advisor Name

Department

STUDENT SIGNATURE Owen Sinderman

DATE: ____________________

Owen Sinderman

Western Washington University, College of the Environment

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Institute for Watershed Studies Internship Report

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Introduction

This past quarter I have interned with the College of the Environment's very own Institute for Watershed Studies (IWS), one of several research institutions associated with the college. The IWS performs several roles, both within the university and with external government and non-government organizations. Among these are assistance with student projects, program development, sponsorship of watershed-related seminars, and provision of equipment and knowledge for water quality monitoring and research. One of the main projects of the IWS is the Lake Whatcom monitoring program, a large-scale watershed study that has been collecting data since 1988. During my time with the Institute, I assisted primarily in this project, specifically with the tributary stormwater and lake water quality aspects. I additionally got a chance to help with the start of a new monitoring program for Wiser Lake spearheaded by the Whatcom County Health Department, which is utilizing the IWS lab for analysis of field samples. I have enjoyed no shortage of diversity in my duties, being involved in lab work (dissolved oxygen measurements, chlorophyll filtering and measurements, conductivity and pH measurements, total suspended solids (TSS) measurements, container washing, lab maintenance), field work (stormwater sample retrieval, Lake Whatcom bacteria sampling, Wiser Lake water quality sampling), data entry, and data analysis.

Duties Performed

As stated in the previous section, I performed a wide variety of duties while with the IWS. In this section I will expand upon these duties as necessary, starting with those that I was more comfortable with going into the internship and ending with those that I had to develop skills for from the ground up.

Lab Work

In my time at Western, I had taken several lab courses that have helped prepare me for my lab work at the IWS. The first job I was given in the lab was the measurement of TSS from the most recent tributary stormwater samples taken. Total suspended solids, measured in units of mass per unit of water volume, are the undissolved particulate matter in a sample of water. It is of relevance to stormwater monitoring as it can be representative of erosion of bank sediment during a rainstorm, which can additionally be damaging to ecosystems further downstream. In measurement, a sample of water is evaporated, and residual solids baked and desiccated before being weighed. I specifically assisted in the weighing process, which is repeated three times for precision making sure to re-desiccate the samples each time. While weighing the samples, I found that many of them measured off from their previous measurements by 0.5 mg or more and had to flag them to be re-measured.

The second of the lab tasks I was assigned at the IWS was pH and conductivity measurements, also from tributary samples. Both of these parameters refer directly to the chemical makeup of a body of water, measuring the presence of different ions in the sample. These are staple water quality measures, as many aquatic organisms are highly sensitive to fluctuations in them; in the study of a body of water it is of utmost importance to know the chemistry of the tributaries that make up its watershed for this reason. I performed the whole measurement process of these parameters for several tributaries, a procedure which involved pouring out an amount of the sample into a cup, then placing the corresponding parameter electrode inside. We made sure to avoid sample contamination by rinsing electrodes between each measurement, and two of the tributaries were measured twice to make sure methods were consistent.

Next was dissolved oxygen, which I would measure for the Lake Whatcom sampling events. This was also measured by instrument out in the field, but was also done back in the lab to ensure accuracy. Dissolved oxygen is perhaps the most important water quality parameter for an ecosystem, as it represents the ability for organisms to live in a body of water. In a lab, dissolved oxygen is measured by the Winkler titration. Throughout this process, it is important to minimize the interaction between the sample and the air in order to prevent contamination by airborne oxygen. Winkler titration begins with preparing the sample in a glass bottle with concentrated sulfuric acid and iodine. The next steps comprised my duties, which included calibrating the titrant against a control sample prepared similarly to the actual samples only using deionized distilled water as the base, and the actual titration process of adding titrant to the sample until a color shift. For each set of samples measured, one was done in replicate to ensure consistency in procedure.

The last measurement duty I had was chlorophyll, which I performed for Wiser Lake samples. In water quality, chlorophyll is used as an indicator for biological activity and presence of algae/phytoplankton in a body of water. This in turn can be linked to the measurement of eutrophication of a water body. This is a two-day process, where the first is dedicated to filtering and mixing and the second is dedicated to measuring the values. I performed filtration, which involved pouring a known value of the sample from its container onto a filter connected to a vacuum tube. The vacuum pulled out all the water, leaving anything within it on the filter, which was promptly stored in the freezer. From the freezer, filters were submerged in acetone in a test tube; the contents of which were then ground into a slurry and placed back in the freezer. On the second day of chlorophyll analysis, we removed the tubes from the freezer and added a small amount of acid as well as more acetone before placing them in the spectrophotometer for analysis.

In addition to taking measurements in the lab, I also performed a good deal of lab upkeep. It was my responsibility on a weekly basis to clean the benchtops, floor, and carts of the main laboratory as well as change out the pH electrode storage solution and the deionized water in the jugs around the room. Another duty I performed was the washing of sample bottles, which after each use had to be filled with hydrochloric acid, let sit for 24 hours, then the process repeated with water.

Field Work

I had taken some field courses at Western before, but overall the field work done at IWS was a major learning area, as I had never done anything specific to lakes or stormwater, or nearly on the scale of the Lake Whatcom program. Unfortunately, I had limited options to get out in the field due to scheduling conflicts, but was able to on a few occasions.

The first field opportunity I got was the collection of stormwater data from select tributaries following a stormwater event. We drove out to the tributaries, in this case Carpenter and Olsen creeks, where the IWS has ISCO auto samplers set up. These samplers had been programmed before the event to take samples every three hours, and could only store a total of 24 samples. With my supervisor Carmen, I connected the field computer to the sampling machine, and used the provided software to extract the raw data. We then swapped out each of the filled sample bottles for new, empty bottles prepared the day before and returned to campus.

On another occasion, I was able to ride along for the collection of Lake Whatcom bacteria samples. We boated out to each sampling site in the lake- 2 in each basin- where at each I filled a sample from the surface of the water. We then dropped off the samples at the city water treatment plant.

My final, and primary field duty was the assistance of officials from the Whatcom County Health Department in the water quality sampling of Wiser Lake. On the first occasion, we calibrated their YSI water quality probe before driving up to the lake, where we measured at each basin water transparency (by Secchi disk) as well as temperature, dissolved oxygen, pH, and conductivity at intervals of 0.5m starting from the surface. After taking measurements, we bottled samples for orthophosphate, total nitrogen (both at max depth and surface level), chlorophyll, and phycocyanin analysis back at the IWS lab. Afterwards, we travelled to the inlet stream of the lake where we measured dissolved oxygen, temperature, pH, and conductivity and took another sample for nutrient analysis in the lab. On the second occasion, we repeated all of these tasks with the addition of taking stream flow measurements for discharge calculations at both the inlet and outlet streams.

Data

The bulk of the work I performed at the IWS was related to the entry, manipulation, and management of data. This was done in Microsoft Excel, which I was already quite capable in before the internship, but more notably in R, which I had only used briefly in 2021 to create simple graphs and statistical analyses for a class.

Most of what I did in Excel was assembling a large dataset composed of the hourly sampling data from storm events for three of the tributaries, each of which had previously been its own file. In addition to compiling all of the events, I added additional rows containing publicly available time series data for the creeks and surrounding area from USGS and NOAA. In the end, I had a spreadsheet containing hourly hydrology, water quality, and rainfall data for every sampling event recorded at these three tributaries, which became the dataset I did most of my subsequent work with.

My first project with this data was to create time-series plots for each water quality parameter against the monitor stage height (given in inches above the lake surface) during each event at each site. The Institute for Watershed Studies had previously conducted graphing of sampling time-series data with an R script that was coded specifically to the dataset to be graphed. Rather than try to go through and manually rewrite the existing code to fit my dataset, I thought it would be a useful endeavor to rework the older script into a loop that would automatically parse through an input dataset and graph any demanded parameters without any further input, to allow it to be reused in the future with ease. I had never used R as a proper programming language in the past, and while I had some background working in Python and Java, it was still a major learning experience for me. I started by taking one instance of the block of code used to plot an event and removing all specific references to the older dataset, replacing them with generic versions (e.g. site = "AND" replaced with site = siteName). Doing this allowed me to turn it into a function, which takes inputs to create a plot (if they match the dataset). From here, the next step was to make the program automatically fill in the arguments for this function with values from the dataset, and have that process loop through for each event at each site provided. I accomplished this by creating a second function, which first has a loop that runs as many times as there are unique sites in the dataset. Within this loop is another loop, which similarly executes code within for each sample in the site being parsed by the first loop. Finally, within the two loops I put a call for the original function, which would now run for each event within each site. This was the majority of the project, but there was also a good deal of work to be done to make sure it ran smoothly in all cases, for instance if a value was N/A. All of the plots created by this program for the dataset I spliced together can be found in *Appendix A*.

My second project undertaken with this data was to produce some graphs that were useful in a more meta way. My supervisor Carmen was interested in whether there were trends to be found within the sampling data that would be of use for future sampling endeavors. She gave me a few ideas of how to go about this, and I set out to do it in tidyverse- a popular code package for R that changes much of the syntax and produces neat, attractive graphs. This was a major learning curve for me, having never touched this package before. Once again, I wanted to make code that would work with any set of data that one would feed into it, as long as it had the proper column names and formatting. Because of this, I got a good hold on multiple sub-packages within the tidyverse, including ggplot2- which creates plots, dplyr- which manipulates data, and tibble- which reinvents the conventional data frame structure of R. I ultimately was able to make four graphs that displayed relationships between month of year, sampling events, rainfall, and samples kept, which can all be found in *Appendix B.*

Conclusion

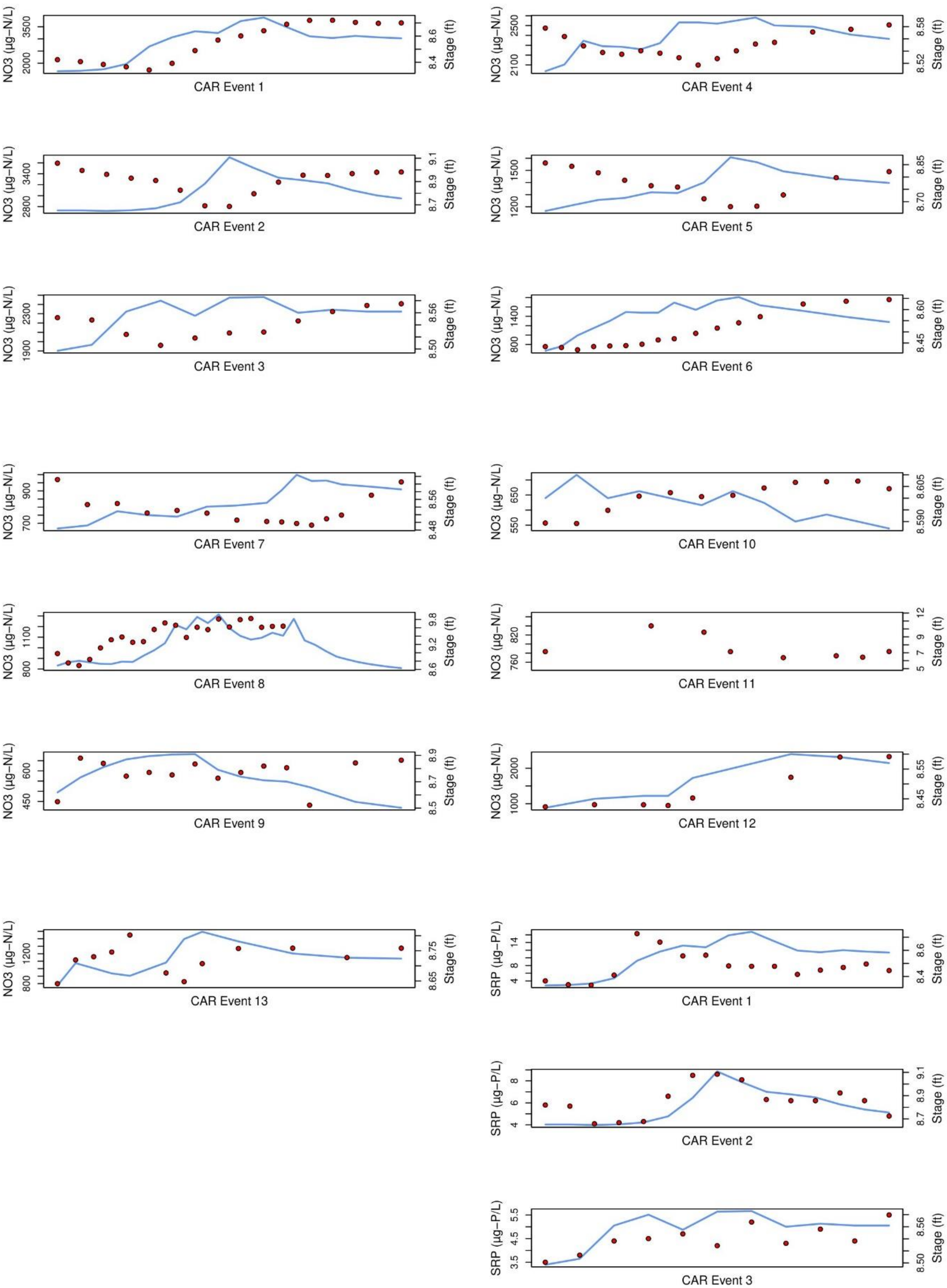
Overall, I think this was a very valuable experience. The highly varied nature of my daily activities lent itself well to this internship acting as a kind of final capstone to my time at Western, and I had the opportunity to nurture and develop numerous skills as well as learn valuable lessons. While I have taken several lab courses in college, I had never gotten the chance to experience working in an actual professional lab before this. While none of the chemistry and procedures being carried out were anything I hadn't done before, albeit with some nicer technology than was used in the classroom labs; it was nonetheless very appreciated to get the chance to put that knowledge to use. My favorite lab class I have taken at Western has been Water Quality (ESCI 361), and just about every lab task done in this position has been based in and built upon concepts learned from there.

This experience marked my first time really being able to get out into the field and do sampling and measurements there. Previously, also in the water quality class, I had gotten the experience of going through all the motions of field sampling, but on a much smaller scale. While I unfortunately got very little time in the field largely due to scheduling issues, I learned a lot from what time I did get, and thoroughly enjoyed every minute. Key areas in which I feel I gained a lot in this regard were knowledge of equipment used in field sampling, knowledge of procedure for taking measurements and samples in the field, and importance of field sampling sites. Given more time, this is absolutely the part of this internship that I would have liked to expand upon and get the chance to do more of.

R was certainly the area in which I learned the most in this position. I essentially had to teach myself how to read and write in both base R as well as tidyverse code styles, with the former at least being made simpler by my light background in conventional programming languages. Tidyverse particularly challenged me for this reason, as it bears little semblance to these languages. With this challenge however came learning, and I picked substantially more than I previously had on graph making, debugging code, function writing, and automation. While I did greatly enjoy the coding process when things were going well, I found myself growing quite frustrated at times when issues would arise. Due to this, I am very grateful for the fact that I had other work in the lab and field to pull me away from the computer when I needed a break. Overall, I'm quite proud of the progress I've made in this time as well as of the programs I've written and the graphs they output.

In all, I had a good time with all of my duties in this internship, and would love to expand upon any and/or all of them as I move into a career in this field. This past Spring, I have learned much both related to my duties and about professionalism, and the water quality field at large. I thoroughly hope to continue to be able to develop and apply this knowledge in my career as I say goodbye to Western.

Appendix A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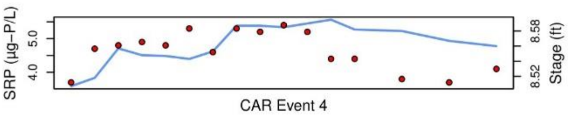

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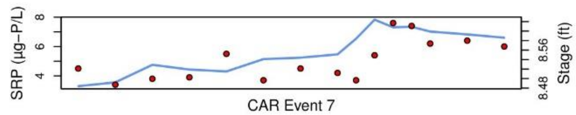

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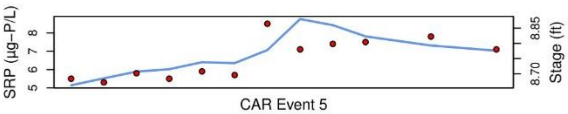

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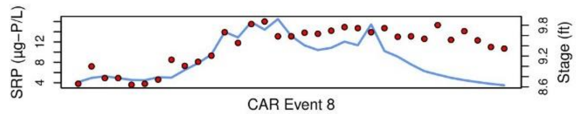

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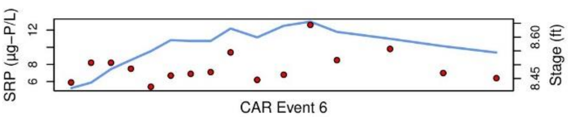

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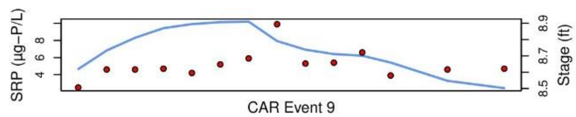

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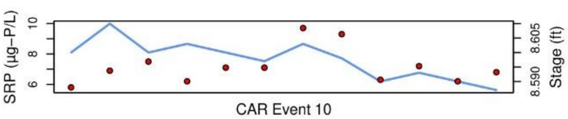

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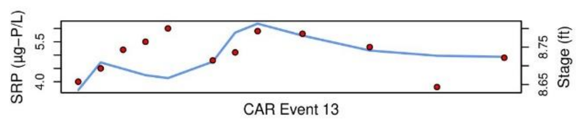

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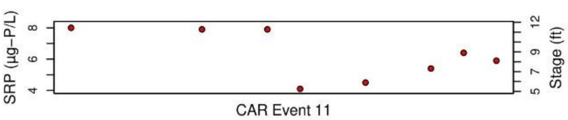

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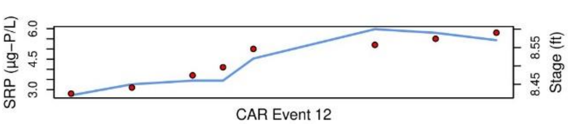

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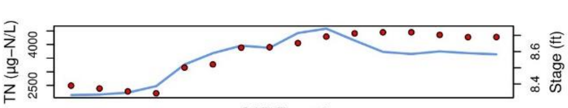

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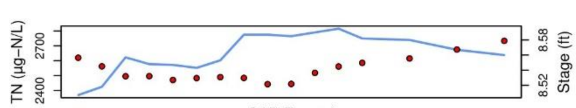

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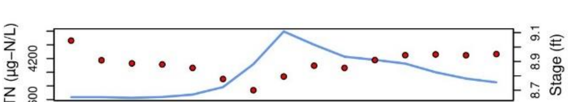

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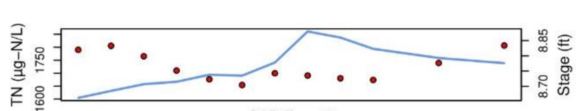

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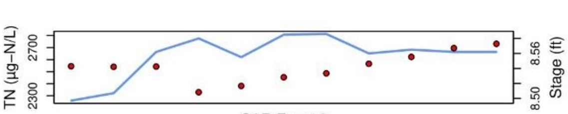

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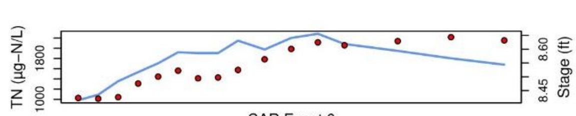

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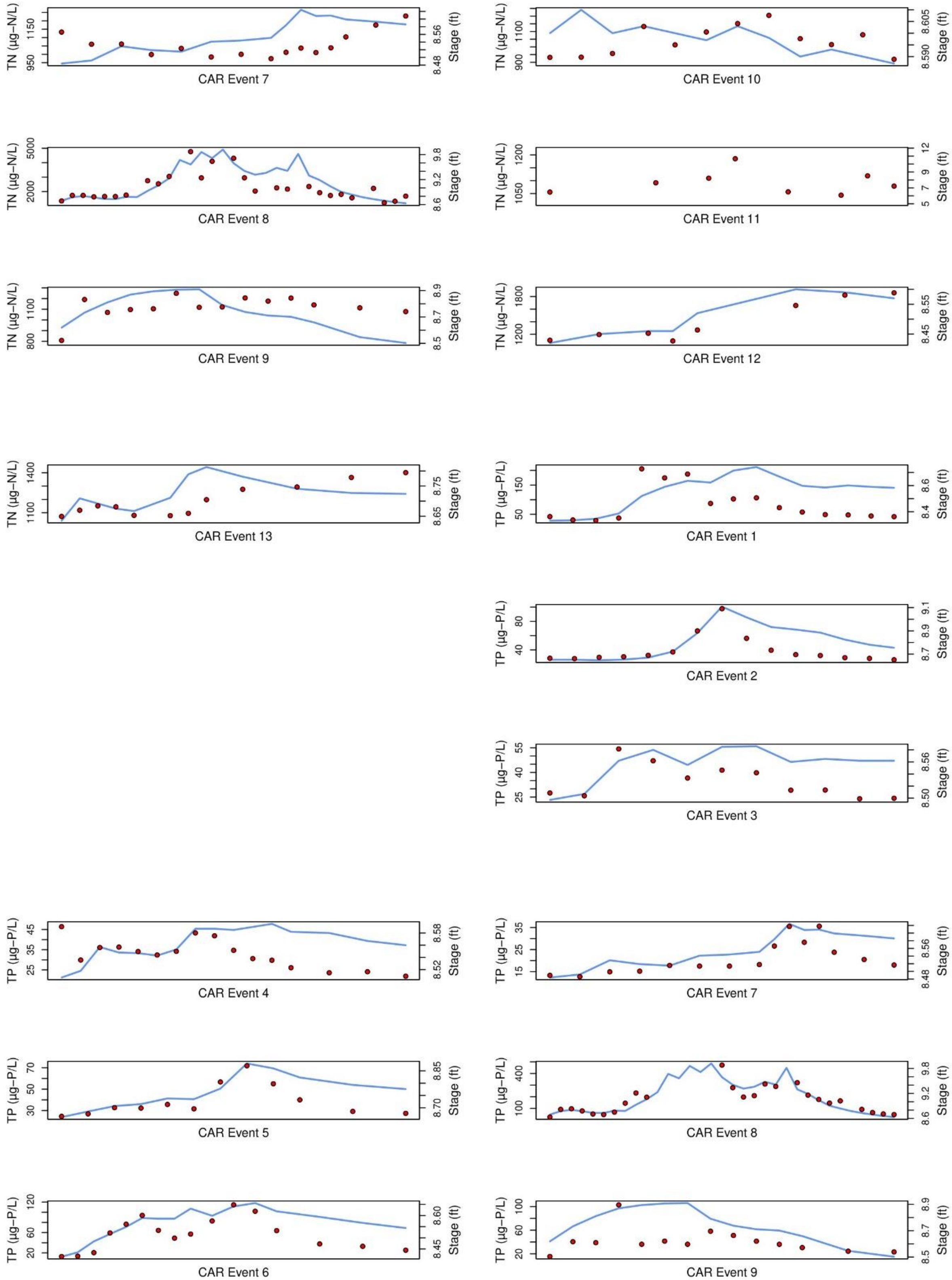
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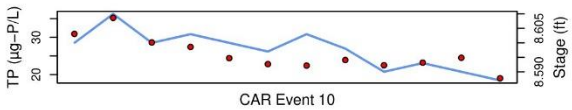
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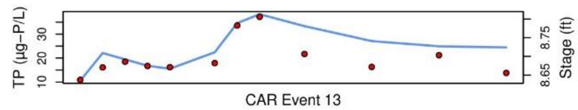
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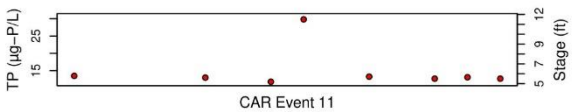
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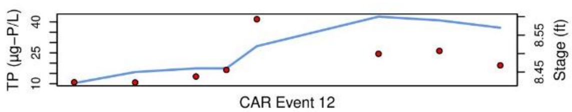
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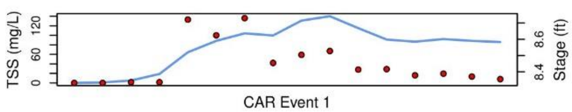
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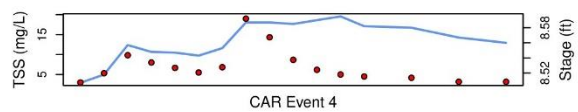
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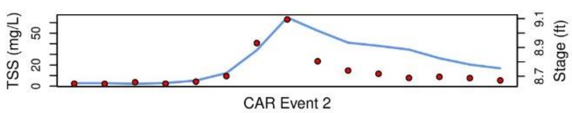
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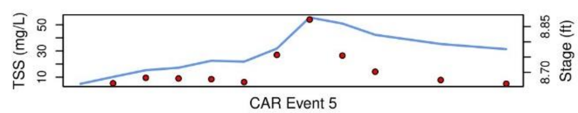
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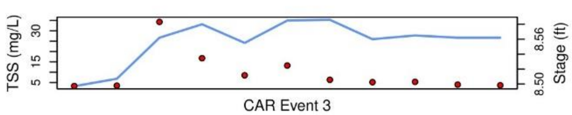
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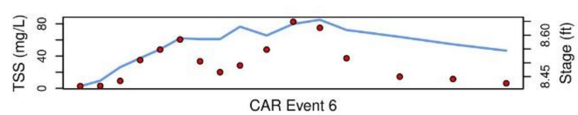
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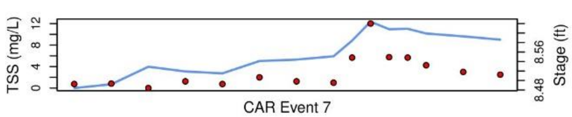
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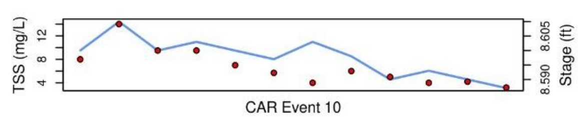
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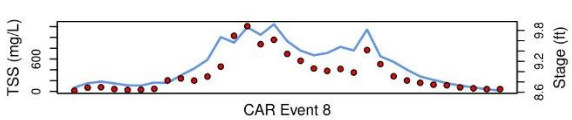
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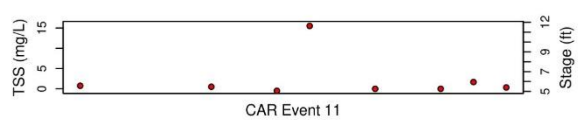
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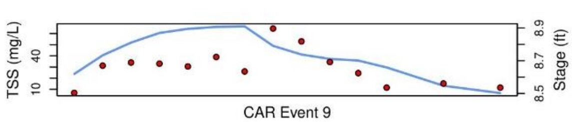
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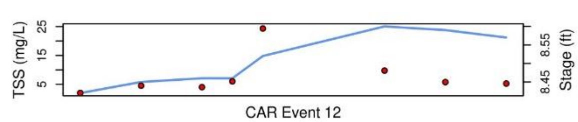
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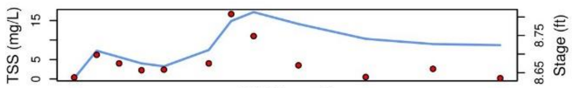

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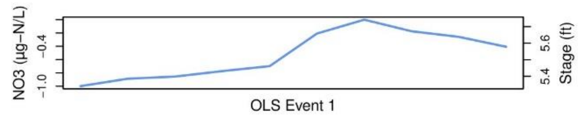
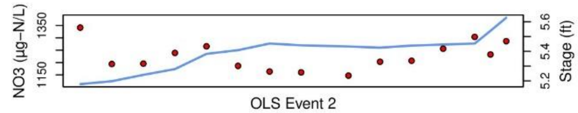
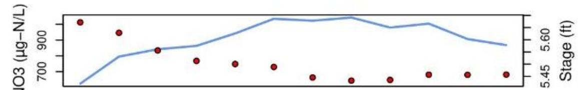


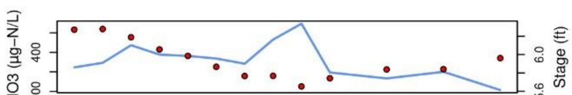
OLS Event 1



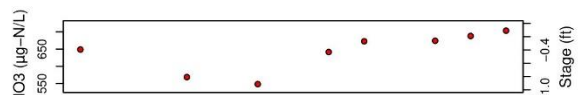
OLS Event 2



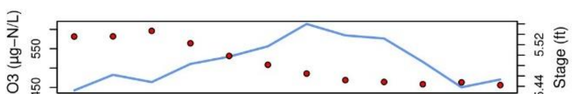
OLS Event 3



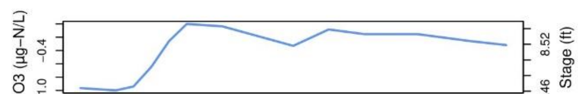
OLS Event 4



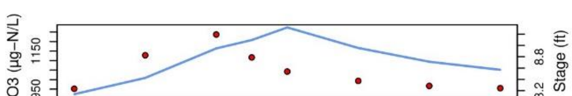
OLS Event 7



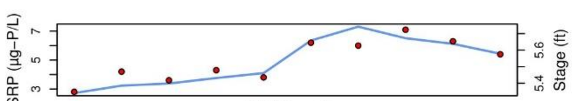
OLS Event 5



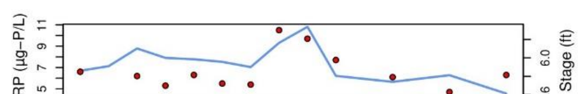
OLS Event 8



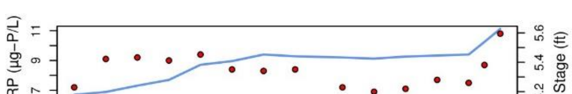
OLS Event 6



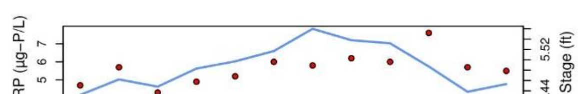
OLS Event 1



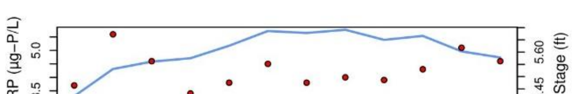
OLS Event 4



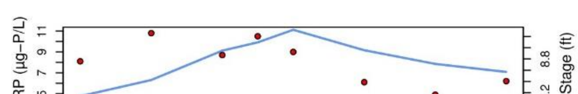
OLS Event 2



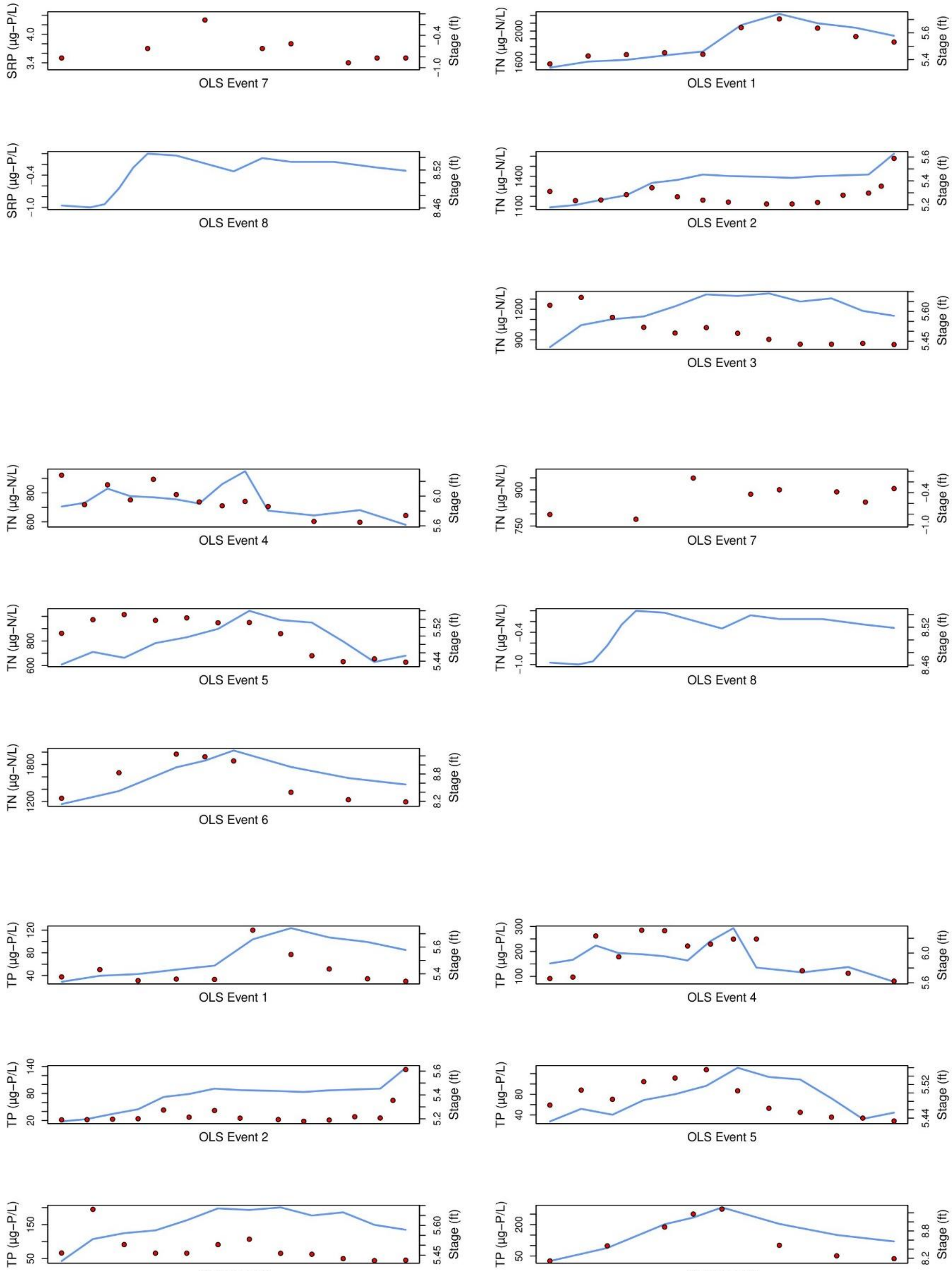
OLS Event 5



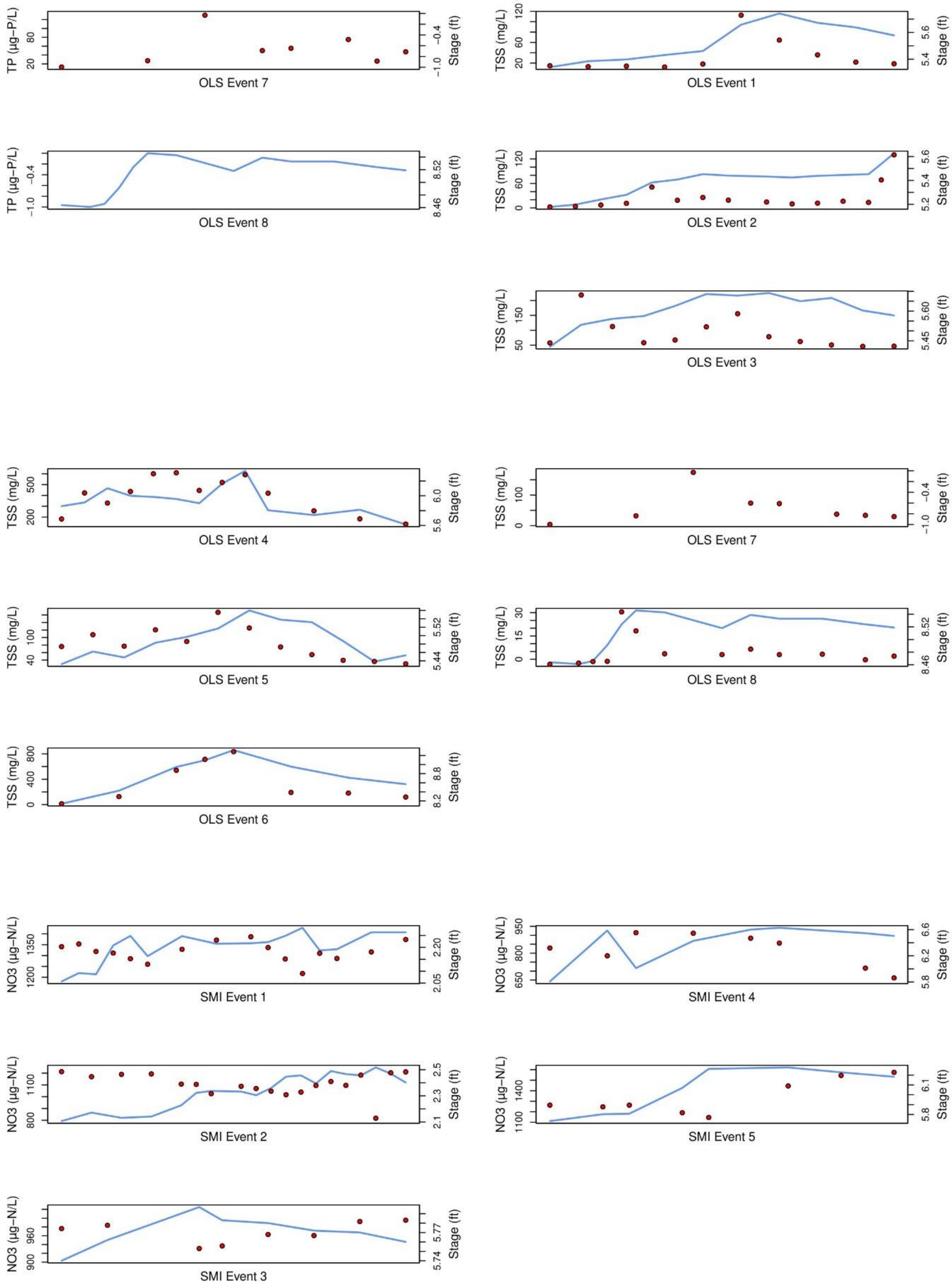
OLS Event 3



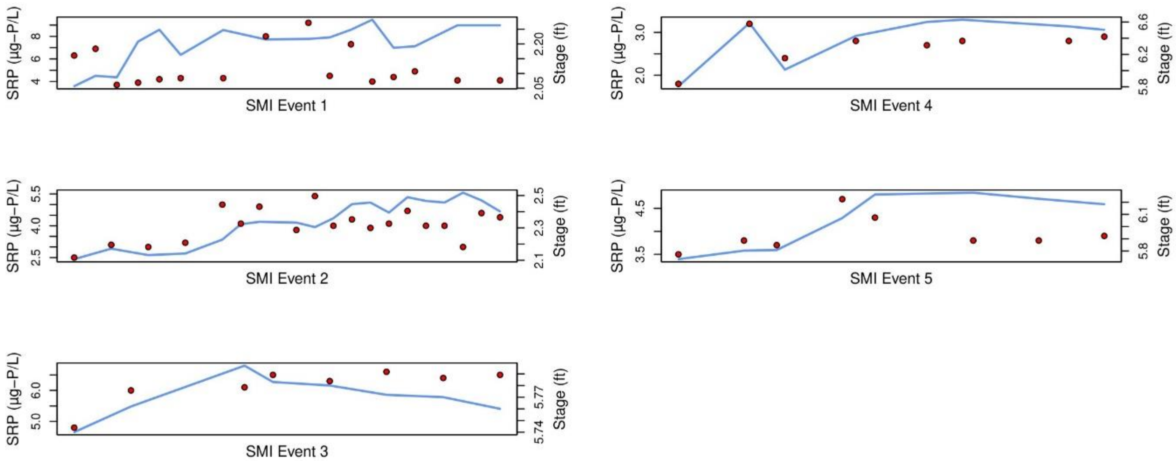
OLS Event 6

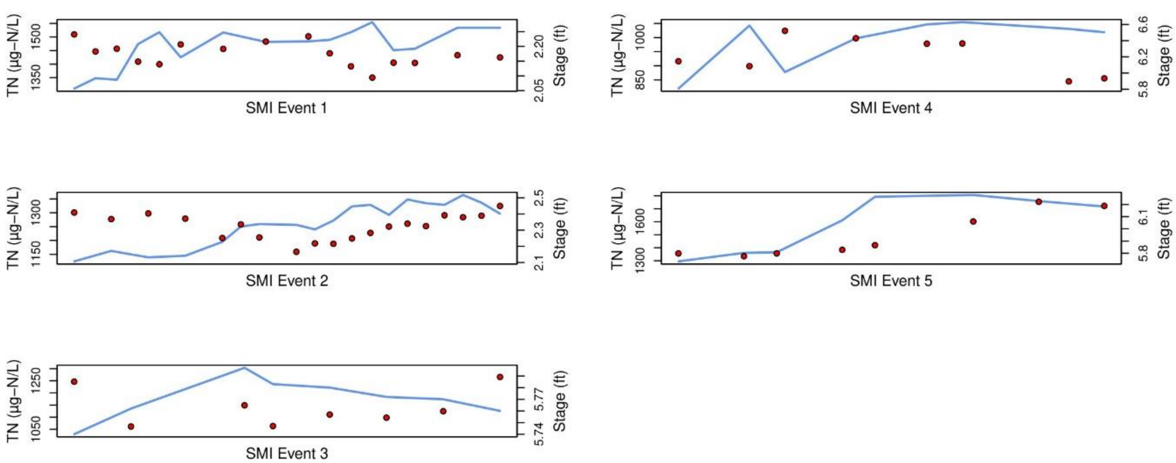


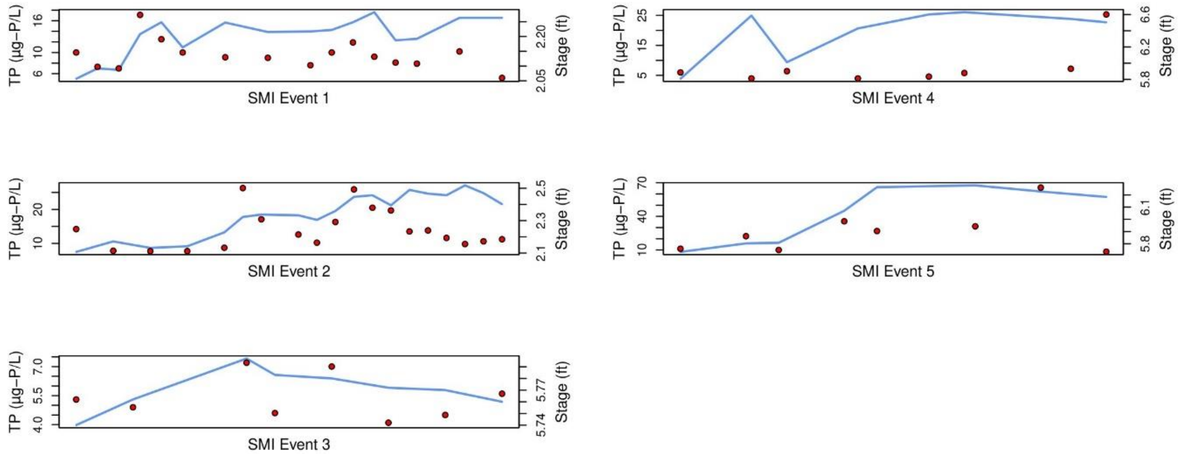
SRP (µg−P/L)
Stage (ft)
OLS Event 7
TN (µg−N/L)
Stage (ft)
OLS Event 1
SRP (µg−P/L)
Stage (ft)
OLS Event 8
TN (µg−N/L)
Stage (ft)
OLS Event 2
TN (µg−N/L)
Stage (ft)
OLS Event 3
TN (µg−N/L)
Stage (ft)
OLS Event 4
TN (µg−N/L)
Stage (ft)
OLS Event 7
TN (µg−N/L)
Stage (ft)
OLS Event 5
TN (µg−N/L)
Stage (ft)
OLS Event 8
TN (µg−N/L)
Stage (ft)
OLS Event 6
TP (µg−P/L)
Stage (ft)
OLS Event 1
TP (µg−P/L)
Stage (ft)
OLS Event 4
TP (µg−P/L)
Stage (ft)
OLS Event 2
TP (µg−P/L)
Stage (ft)
OLS Event 5
TP (µg−P/L)
Stage (ft)
OLS Event 3
TP (µg−P/L)
Stage (ft)
OLS Event 6

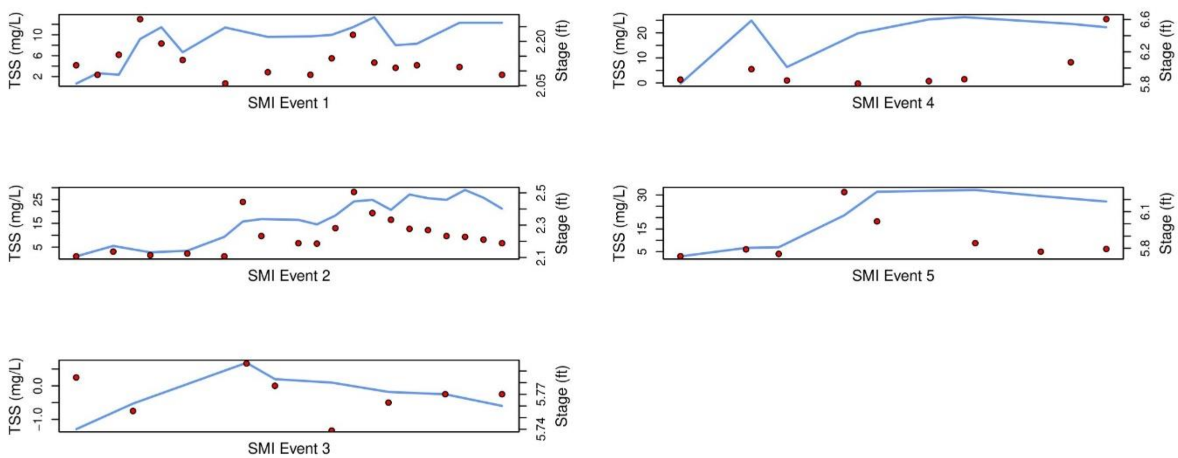


TP (µg−P/L)
Stage (ft)
OLS Event 7
TSS (mg/L)
Stage (ft)
OLS Event 1
TP (µg−P/L)
Stage (ft)
OLS Event 8
TSS (mg/L)
Stage (ft)
OLS Event 2
TSS (mg/L)
Stage (ft)
OLS Event 3
TSS (mg/L)
Stage (ft)
OLS Event 4
TSS (mg/L)
Stage (ft)
OLS Event 7
TSS (mg/L)
Stage (ft)
OLS Event 5
TSS (mg/L)
Stage (ft)
OLS Event 8
TSS (mg/L)
Stage (ft)
OLS Event 6
NO3 (µg−N/L)
Stage (ft)
SMI Event 1
NO3 (µg−N/L)
Stage (ft)
SMI Event 4
NO3 (µg−N/L)
Stage (ft)
SMI Event 2
NO3 (µg−N/L)
Stage (ft)
SMI Event 5
NO3 (µg−N/L)
Stage (ft)
SMI Event 3


SRP (µg−P/L)
Stage (ft)
SMI Event 1
SMI Event 2
SMI Event 3
SMI Event 4
SMI Event 5

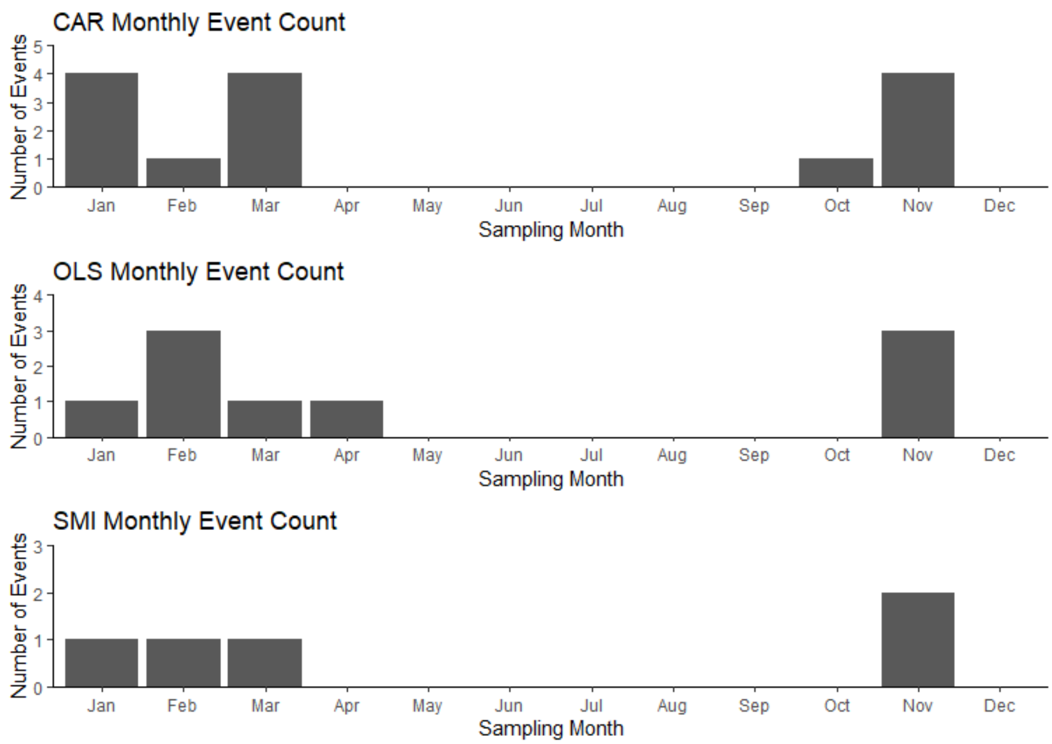

TN (µg−N/L)
Stage (ft)
SMI Event 1
SMI Event 2
SMI Event 3
SMI Event 4
SMI Event 5



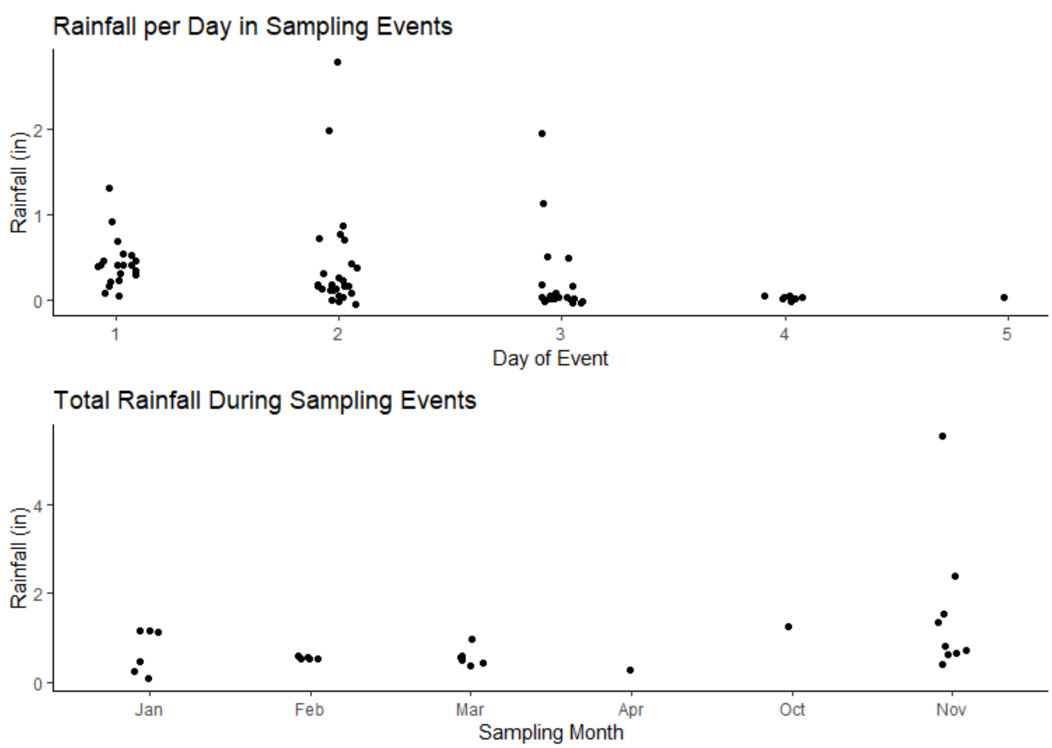


Figures 1-130: NO3, srp, TN, TP, and tss over the course of each event at each site plotted alongside stage height.

Appendix B



Figures 131-133: Number of recorded events during each month at each sampling site.



Figures 134 and 135: Rainfall variance over day and month during rain events sampled.

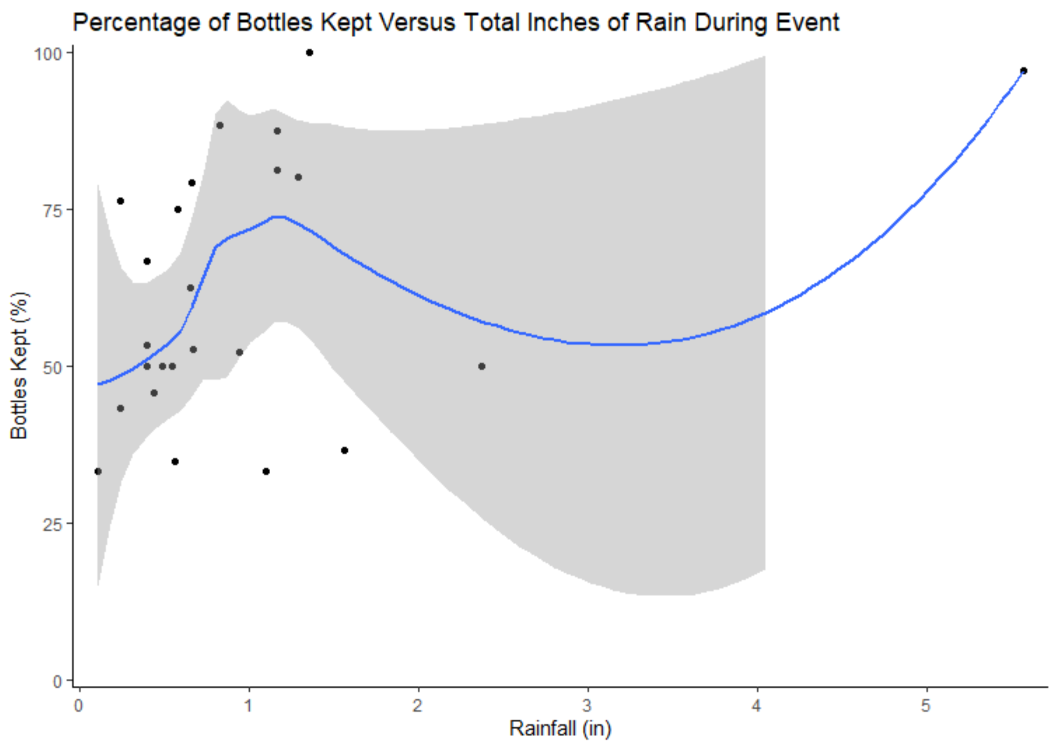


Figure 136: Percent of sampling bottles kept plotted as a function of total rainfall. Grey area represents 95% confidence intervals.

Appendix C

Weekly/Daily Tasks

Week #	Date	Time In	Time Out	Tasks worked On
	3/27/2023	14:30	15:30	Onboarding
1	3/29/2023	9:00	16:30	Onboarding, TSS
	4/3/2023	9:00	16:30	Onboarding
	4/4/2023	14:00	16:00	Lake sample conductivity+pH
2	4/5/2023	11:00	16:30	Winkler DO, Data Entry
	4/10/2023	9:00	16:30	Trib sampling, Data Entry
3	4/12/2023	9:00	16:30	Learning R
	4/17/2023	9:00	16:30	Learning R
4	4/19/2023	9:00	16:30	Lake Bacteria sampling, Bottle Washing
	4/24/2023	9:00	16:30	Wiser Lake Background Research
5	4/26/2023	9:00	16:30	Winkler DO, Rewriting R Script

	5/1/2023	9:00	16:30	Rewriting R, Wiser debrief
	5/3/2023	9:00	15:30	R, Wiser Chl filtering
6	5/4/2023	14:00	15:00	Wiser Chl readings
	5/8/2023	9:00	16:30	Downrigger Calibration, tidyverse learning
7	5/10/2023	9:00	16:30	Winkler DO, tidyverse learning
	5/15/2023	9:30	16:30	Wiser Lake Sampling, tidyverse learning
8	5/17/2023	9:00	17:00	Bottle Washing, tidyverse learning
	5/22/2023	9:00	16:30	coding
9	5/24/2023	9:00	16:30	coding
10	5/31/2023	9:00	16:30	coding, working on paper
11	6/5/2023	9:00	16:30	Wiser Lake Sampling, working on paper