Storm Chasers: The Correlation Between Water Discharge, Suspended Solids, and Nutrients During Storm Events in the Mad River

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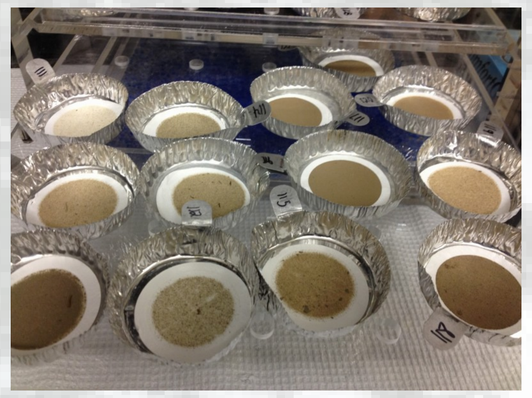
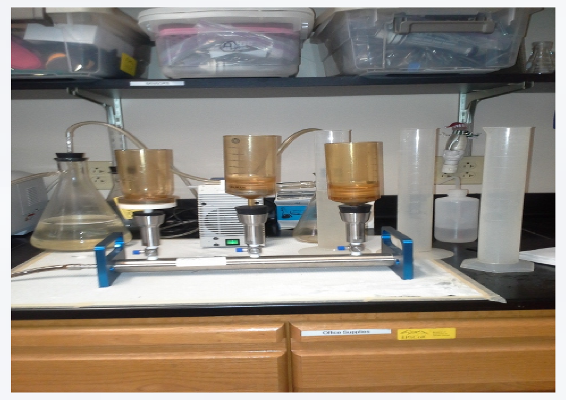


(Left) Filtered samples, completed. (Right) Local stream.



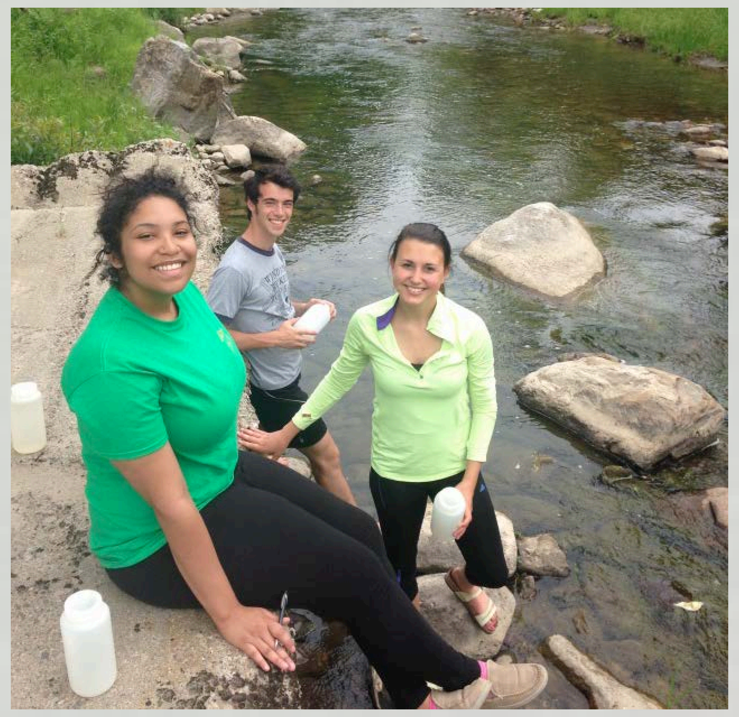
(Left) Acid washing ISCO sample bottles. (Right) Filtration apparatus, used to extract suspended solids.

Introduction:

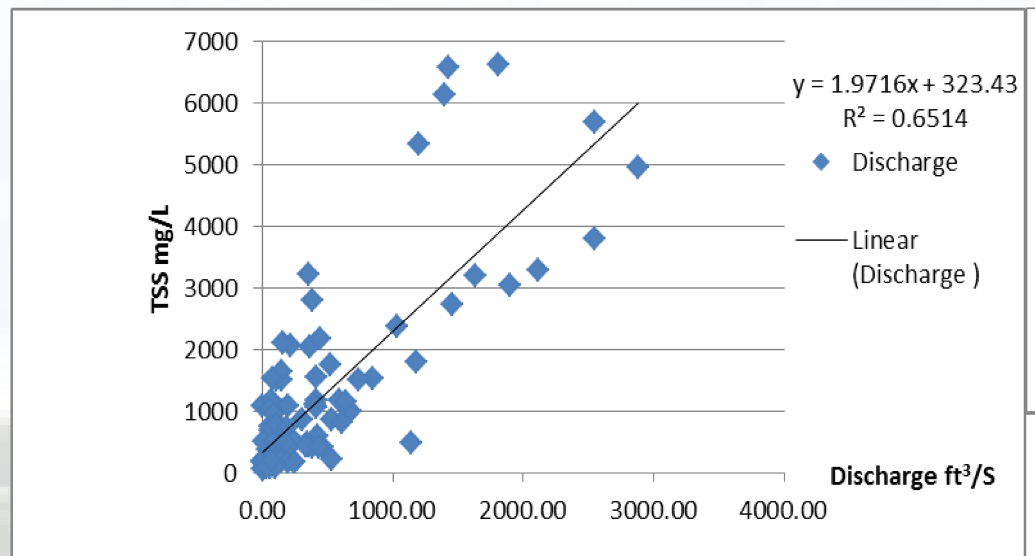
- The Winooski watershed includes four counties in Vermont, and drains into Lake Champlain. It is the largest contributing watershed to the lake, spanning 1,080 square miles. The Mad River, a part of the watershed, combines with the Winooski in Moretown, and is 26 miles long. (*Winooski Watershed, 2014)*
- Total Suspended Solids (TSS) are simply solid sediments that are present in the water and occur naturally in Lake Champlain, as well as in any waterway that is connected to it. Phosphorus and Nitrogen are also found in these areas, and can be harmful to the environment when present in excess.
- "The large size of Lake Champlain's watershed, relative to lake volume, makes the lake vulnerable to land use changes." (*Medalie et al, 2012*) The surplus of TSS that is currently present in the Winooski watershed, as well as Lake Champlain, comes from multiple sources, many of which are anthropogenic—from agricultural pollution, to deforestation, and waste water influx.
- Storms have a powerful effect on a river, increasing discharge and therefore impacting sediments and nutrients. This project focused on the patterns of flow and sediment movement of rivers and streams in the Winooski watershed during storms. Data from the Mad River was analyzed, while similar studies focused on Essex and Montpelier observation sites on the Winooski River.
- Total Suspended Solids (TSS) were compared to discharge, Total Phosphorus, and Total Nitrogen content in the samples that were collected in 2013. Additionally, patterns between storm water flow and nutrient discharge were explored by studying one large storm from 2013 data (July 4th).
- When water levels rise, currents grow stronger and sediments are stirred up. With this in mind, I predict that with an increase in water discharge will come an increase in recorded levels of TSS, Phosphorus, and Nitrogen.

Methods and Materials:

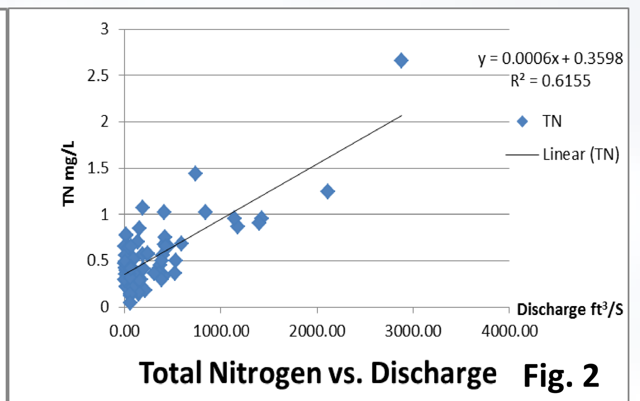
- My group utilized ISCO machines which were programed to take water samples when the river height rose and fell. These were set up at sites on the Winooski River in Essex and Montpelier, and on the Mad River in Moretown. Once these devices were activated, the samples they took could be cross referenced with data from the USGS. Once samples were taken, our group would return to the sites and collect the bottles, restocking them with clean ones, which was done weekly. Half of the samples would go to the laboratory at Johnson State College, where they-would be tested for nutrients such as Phosphorus and Nitrogen. The other half were tested by our group at Saint Michael's, mainly for total suspended solids (TSS).
- All bottles that were taken to the lab at Saint Michael's were analyzed for TSS, protocols based off of Standard Methods for the Examination of Water & Wastewater (APHA 2005) and Wetzel & Likens 2000. Bottles were logged in and stored in a refrigerator. The group would measure these samples using a filtration device that caught the solids on small microfiber filters.
- Once completed, they were logged into an Excel spreadsheet where final calculations were made. Blank samples were always recorded using RODI water for a baseline check.
- Bottles that were taken to the Johnson State lab were logged, tested, and recorded in a similar fashion, and Johnson State interns would test for nutrients such as Phosphorus and Nitrogen, following EPA method (NH4) and 35 3.2 (NO3).
- Analyzing the recorded data through Excel, the group graphed the recorded information from the 2013 data, and came to conclusions accordingly. 2013 data was accessed so as to accurately reflect a full year's worth of information.



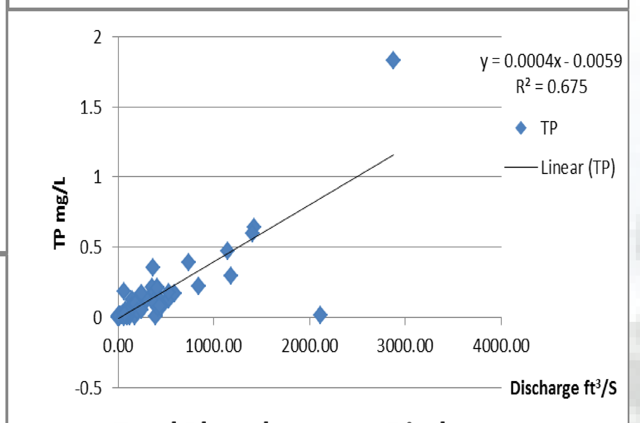
Results:



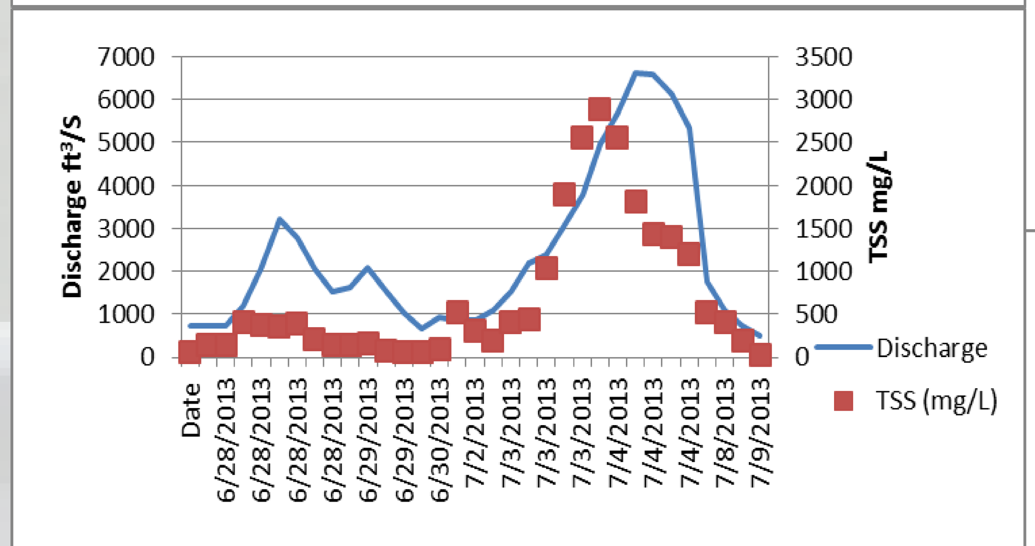
TSS vs. Discharge 2013 Fig. 1



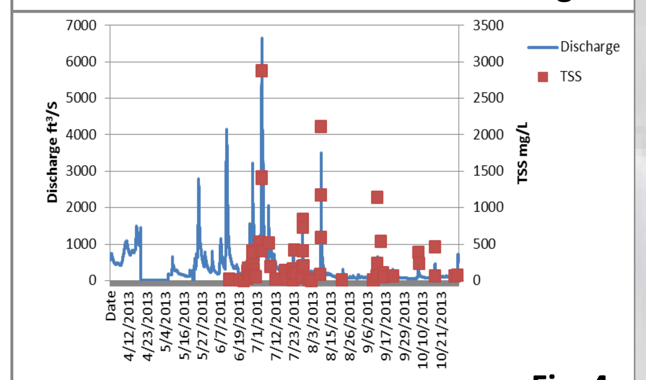
Total Nitrogen vs. Discharge Fig. 2



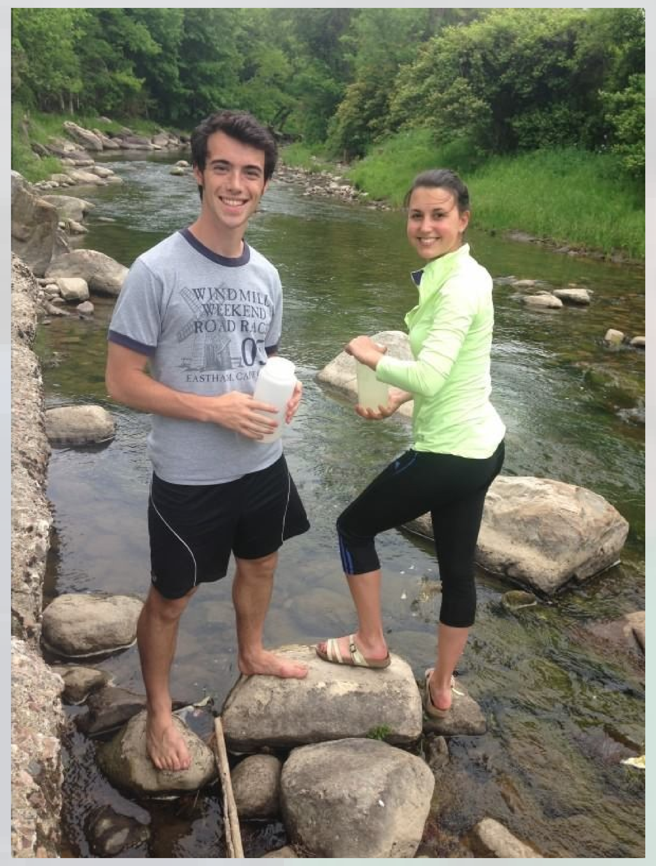
Toral Phosphorus vs. Discharge Fig. 3



July 4, 2013 Discharge vs. TSS Fig. 5



Discharge with TSS Fig. 4



Clockwise:

Figure 1: Overall Total Suspended Solids and overall Discharge for the year of 2013.
Figure 2: Total Suspended Solids and Total Nitrogen levels for 2013.
Figure 3: Total Suspended Solids and Total Phosphorus levels combined for 2013.
Figure 4: Discharge for the year of 2013 with TSS (line graph version) TSS absent from first half because samples were not taken at that time.
Figure 5: Discharge vs. TSS levels for a particular storm on July 4th, 2013.
*All graphs represent data from the Mad River.

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***6.** Winooski Watershed:* (2014) http://www.winooskiriver.org/Winooski_Watershed

Discussion:

- Overall, the group covered a large portion of the watershed, and analyzed what kinds of relationships were present between TSS and nutrients and how they were released during storms.
- My hypothesis that with an increase in water discharge will come an increase in recorded levels of TSS, Phosphorus, and Nitrogen, was supported, as shown in figures 1, 2, and 3. Here, significant R squared values of .6514 (Fig 1), .6155 (Fig. 2), and .675 (Fig. 3) reveal that discharge and sediment levels have a statistically significant correlation with one another.
- During the July 4th storm, the sediment peaked prior to peak flow, as shown in Figure 5.
- In the future, it would be exciting to look deeper into the relationship between sediment discharge and storm water discharge. As shown in Figures 4 and 5, it seems that sediment discharge peaks before the highest amount of storm water discharge does. Future research could involve tracking this potential pattern at different stream sites as well as at current ones. This information could be analyzed during different conditions including storm weeks as well as regular flow weeks. It could then be looked at from the standpoint of multiple years in order to observe individual, but possibly connected results.

(Above) Bottles used to collect river samples.
(Right) Finished samples ready to be analyzed and recorded.

Acknowledgements:

I would like to thank Saint Michael's College for providing my lab partners and I with a place to conduct research, and the tools with which to do so. I am also happy to acknowledge Declan McCabe and Katie Chang for their guidance, as well as Baxter Miatke, Natalie Ledue, Jaleeza Johnson, Kerrie Garvey, and Lindsay Wieland for their constant support. I am grateful to Johnson State College, particularly Saul Blocher and his interns, for their assistance with analysis. Funding provided by NSF Grant EPS-1101317.