A Look at Land Use, Nutrient, Sediment Trends Among Stream Sites in the Winooski and Missisquoi Watersheds

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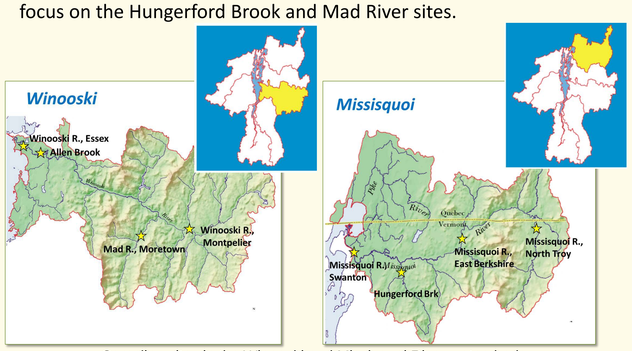
Background

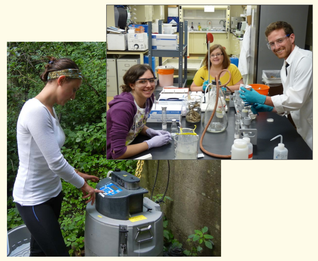
The overarching goal of Vermont EPSCoR's center on Research on Adaptation to Climate Change (RACC), is to address how climate change and land use will impact hydrological processes and nutrient transport over the landscape, and in turn, how this will effect Lake Champlain. To help understand some of these processes, RACC researchers installed seven automated samplers at stream sites within the Winooski and Missisquoi River watersheds. This poster provides an overview of the data obtained in 2012 and 2013 with a focus on the Hungerford Brook and Mad River sites.



Sampling sites in the Winooski and Missisquoi River watersheds.

Methods

- The stream sites were selected to pair samplers with existent USGS gaging stations for linking with flow and stage data.
- Samplers were typically installed at stream sites in early June, sampled throughout the season, and removed at the end of October.
- The site-specific sampling programs were provided by USGS and programmed to collect water samples in response to stage and rate of change, with the goal of capturing the full range of storm events.
- Total suspended solid samples were analyzed at St Michaels College. Nutrient analysis was conducted at Johnson State College.



- Land use data was calculated in ArcGIS using existent LCLU data. Similar land use types were clustered together into three focus categories: forest, urban, or agricultural.

Results

Linear regression analysis (see Table 1) showed strong positive relationships between:

- TSS and discharge at all sites (R^2 values ranging between 0.30 and 0.68)
- TP and discharge at all sites, except Winooski R. at Montpelier (R^2 between 0.30 and 0.58)
- TP and TSS at all sites, except Winooski R. at Essex (R^2 between 0.39 and 0.85)
- TN and TSS at the Mad River, Missisquoi R. at N. Troy and Swanton (R^2 between 0.35 and 0.65)

Organized by most urban (5.2%) → to least urban (0.8%)

Regression	Hungerford Brook	Winooski R. at Monteplier	Winooski R. at Essex	Missisquoi R. at E. Berkshire	Missisquoi R. at Swanton	Missisquoi R. at N. Troy	Mad River	Trend
TSS vs Discharge	**0.32**	**0.51**	**0.48**	**0.41**	**0.68**	**0.30**	**0.57**	
TP vs TSS	**0.46**	**0.46**	0.21	**0.39**	**0.80**	**0.72**	**0.85**	
TP vs Discharge	**0.36**	0.25	**0.44**	**0.37**	**0.58**	**0.51**	**0.30**	
TN vs TSS	0.01	0.17	0.19	0.23	**0.35**	**0.42**	**0.51**	
TDP vs Discharge	**0.47**	0.00	0.01	0.08	0.05	0.24	0.25	
TDN vs Discharge	**0.36**	0.24	**0.34**	0.09	0.02	0.03	0.00	
SRP vs Discharge	**0.41**	**0.26**	0.06	0.05	0.04	0.00	0.15	

Table 1. This table provides R^2 values for linear regressions . Significant R^2 values greater than 0.3 are in bold. Other regressions with an R^2 of less than 0.3 were omitted.

- The Hungerford Brook site had the smallest watershed area (see Table 2), but the highest average values for all water chemistry parameters analyzed. This included the highest samples within the dataset for SRP, NOx, TN, TDP, and TDN (see Figure 1). Furthermore, Hungerford Brook was calculated to have the highest percentage of agricultural and urban land use. Hungerford Brook also had the strongest linear regression for TDP vs discharge (R^2 of 0.47), SRP vs discharge (R^2 of 0.41), and TDN vs discharge (R^2 of 0.36) (see Table 1).
- In contrast, the Mad River sampling site was calculated to have the lowest percentage of agricultural and urban land use, and the highest percentage of forested land (see Table 2). The site also had highest average TSS and NH_3 values, the lowest average TDN, and the strongest TN and TSS relationship.

Site Name	Catchment Area Km^2	Percent Agriculture	Percent Urban	Percent Forested
Hungerford Brook	**48**	**56.8**	**5.2**	**35.2**
Mad River	359	**9.0**	**0.8**	**88.3**
Missiquoi R. at North Troy	344	11.9	1.0	83.0
Missisquoi R. at East Berkshire	1239	15.8	2.3	78.9
Missisquoi R. at Swanton	**2205**	20.2	2.3	74.2
Winooski R. at Essex	1883	12.9	3.0	78.4
Winooski R. at Montpelier	1024	12.9	3.3	77.7

Table 2. Total watershed area and land use percentages for all stream sites.

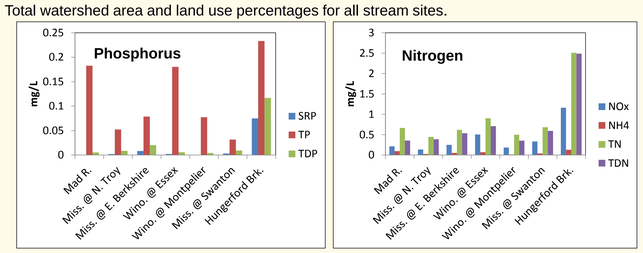


Figure 1. Average phosphorus and nitrogen parameters for 2013. Organized in order of most forest to least forest.

Trends in land use were observed by organizing R^2 values (see Table 1). It was found that:

- As urban area decreased, the TN vs. TSS relationship became stronger (from R^2 0.01to 0.65)
- As urban area decreased, the TDN vs. discharge relationship became weaker (R^2 0.36 to 0)
- As urban area decreased, the SRP vs. discharge relationship became weaker (R^2 0.41 to 0.15)
- As total watershed area decreased, TSS vs. discharge relationship became weaker (R^2 0.68 to 0.30)
- As total watershed area decreased, TDP vs. discharge relationship became stronger (R^2 0.01 to 0.47)

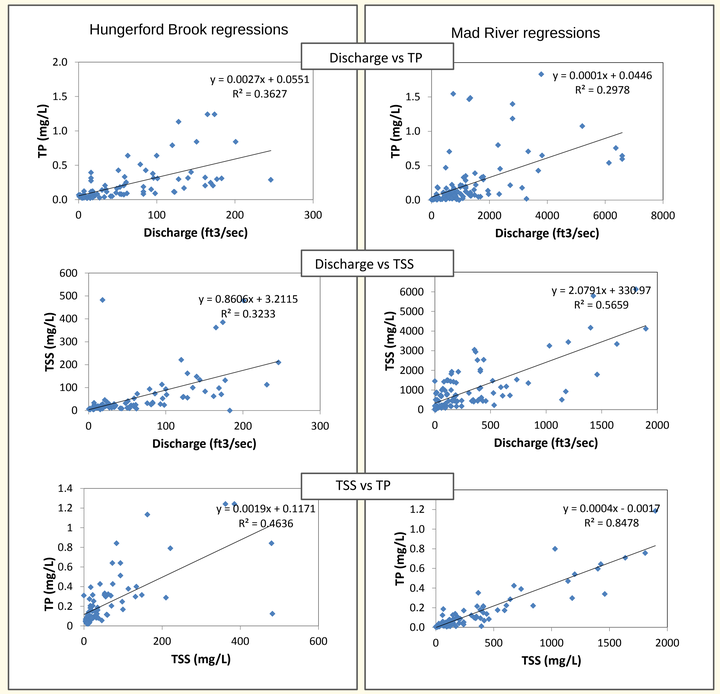


Figure 2. Linear regressions for Hungerford Brook and the Mad River.

Discussion

- Increasing stream flows would be expected to contribute to an increase in sediment and particulate phosphorus. This was observed in that TP, TSS, and discharge were strongly correlated among all sites. Also, this suggests that watershed wide land use and watershed size does not impact these relationships. It was not surprising that other relationships were weakly correlated, such as with nitrogen due to its high mobility in the environment.
- The highest nutrient values were found at Hungerford Brook, the most agriculturally dominated watershed in this study.
- It would be interesting to see if considering local land use (such as within a 30 ft or 100 ft buffer), would suggest anything further.
- It would be prudent to conduct a more detailed analysis, especially as more data is obtained, such as dividing the data by year, season, and even by pre/post storm event.
- It should be noted that this dataset is skewed to a higher range of values, due to the focus of sampling during storm events.

Acknowledgements

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