Quantifying Nutrient Loadings during Spring Runoff in the Missisquoi River Basin

Baxter G. Miatke

Advisors: Andrew Schroth, Donna Rizzo, Arne Bomblies

Introduction

The timing and magnitude of the spring runoff period and associated high nutrient loads, driven by snowmelt and rain, has recently been suggested to be a critical driver of harmful algal blooms in receiving waters during the summer. The objective of this project was to study the biogeochemical and hydro-dynamics of the spring runoff period in the Missisquoi River Basin in Vermont and compare it to annual loading with focus on four United States Geological Survey (USGS) sites. Specifically, this project aims to answer the following research questions:

1) How does spring loading of nutrients and sediment compare to annual loading at each site?

2) What loading spatial patterns within the Missisquoi Basin occur during the spring runoff?

Table 1: Missisquoi River Site Locations/Information

Site	Latitude/ Longitude	Drainage Area	Datum Gage	Station	Threshold
Swanton	44°55'00" 73°07'44"	850 sq. miles	105 ft. above	4294000	2 m
East Berkshire	44°55'06" 73°03'20"	18.6 sq. miles	270 ft. above	4293900	2 m
Hungerford Brook	44°57'36" 72°41'49"	479 sq. miles	402.51 ft. above	4293500	4 m
North Troy	44°58'22" 72°23'09	131 sq. miles	580 ft. above	4293000	3 m

Methods

Figure 2: ISCO Automatic Sampler installed in Missisquoi

Field Methods:

- Automatic Sampler (ISCO) triggered at stage threshold.
- ISCO and baseline grab samples collected at 4 USGS sites for lab analysis.
- Spring required grab samples due to ice.

Lab Methods:

- Total Phosphorus, Soluble Reactive Phosphorus, and Total Nitrogen, analysis performed at Johnson State College Lab
- Total Suspended Solids analysis performed at Saint Michael's College Lab

Load Estimation Methods:

- Linear regression model developed from 2012 to spring 2014 Concentration vs. Discharge data and 15 minute USGS discharge data
- Weighted regression on time, discharge and season (WRTDS) R Script model using same concentration data, but average daily USGS discharge

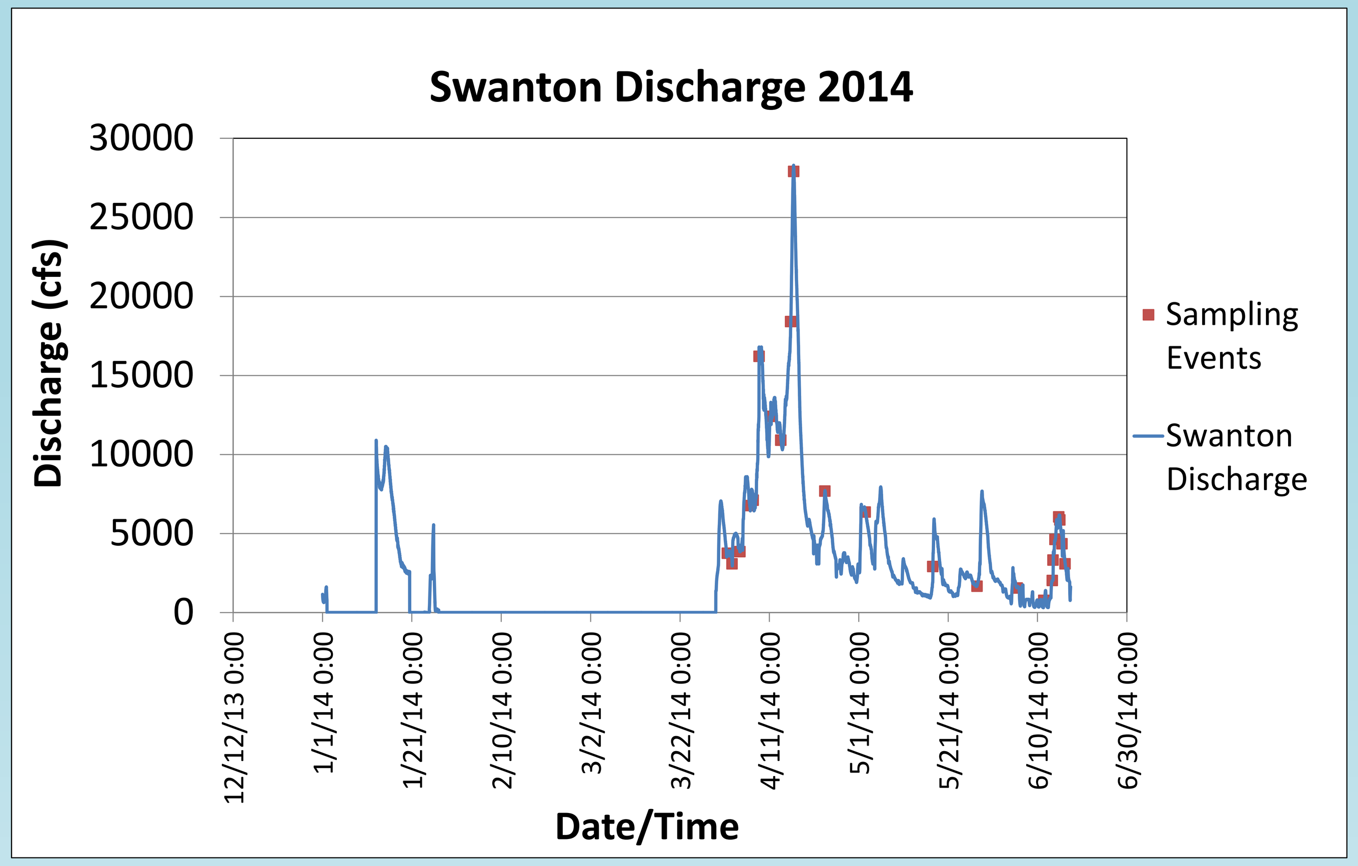

Figure 3: Spring 2014 Swanton Hydrograph with Sampling Events

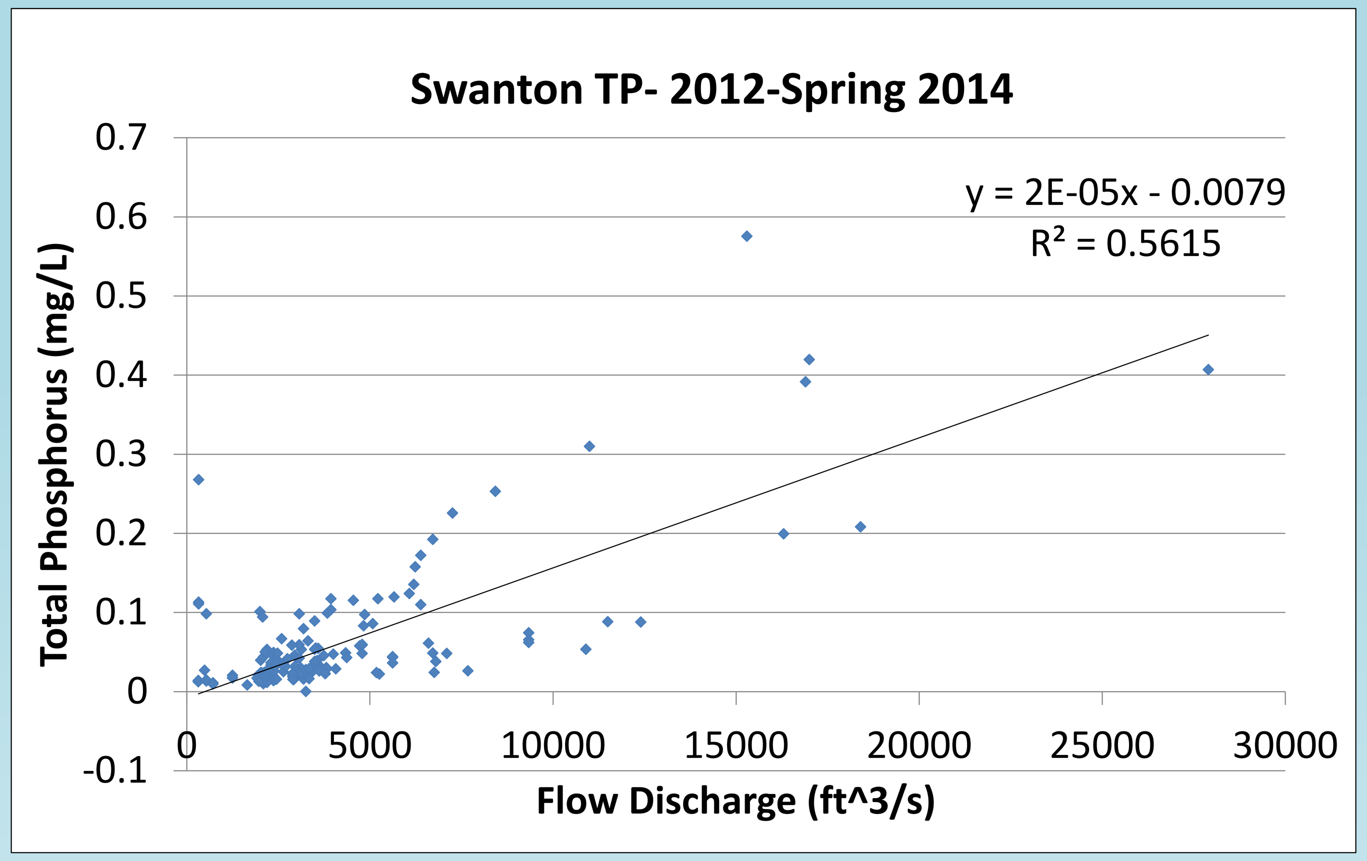

Figure 4: 2012 to Spring 2014 Swanton Total Phosphorus and Discharge

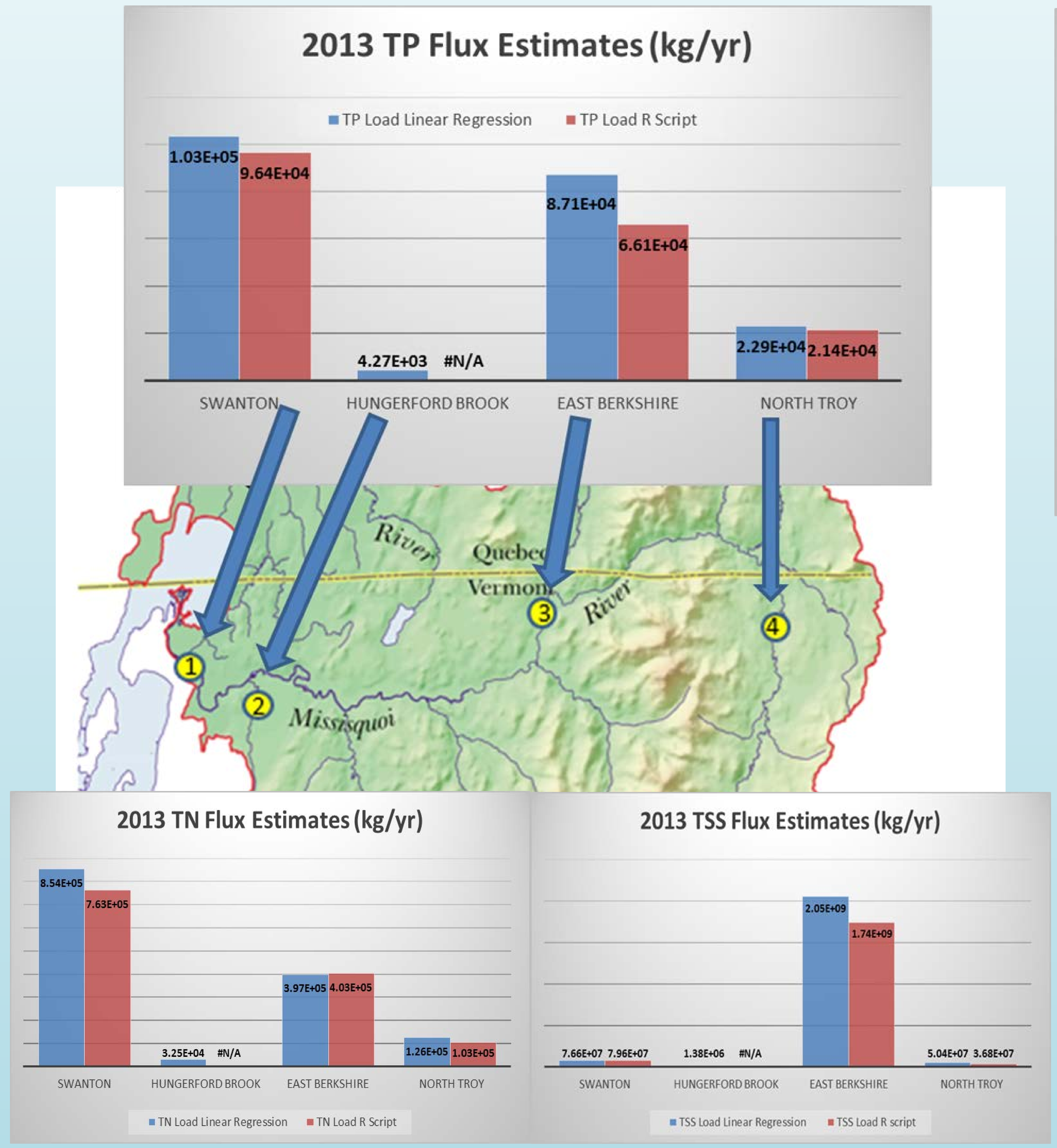

Figure 5: Comparison of *2013 TP, TN, and TSS Flux using Linear and R Script WRTDS Regression Methods in the Missisquoi River Basin*

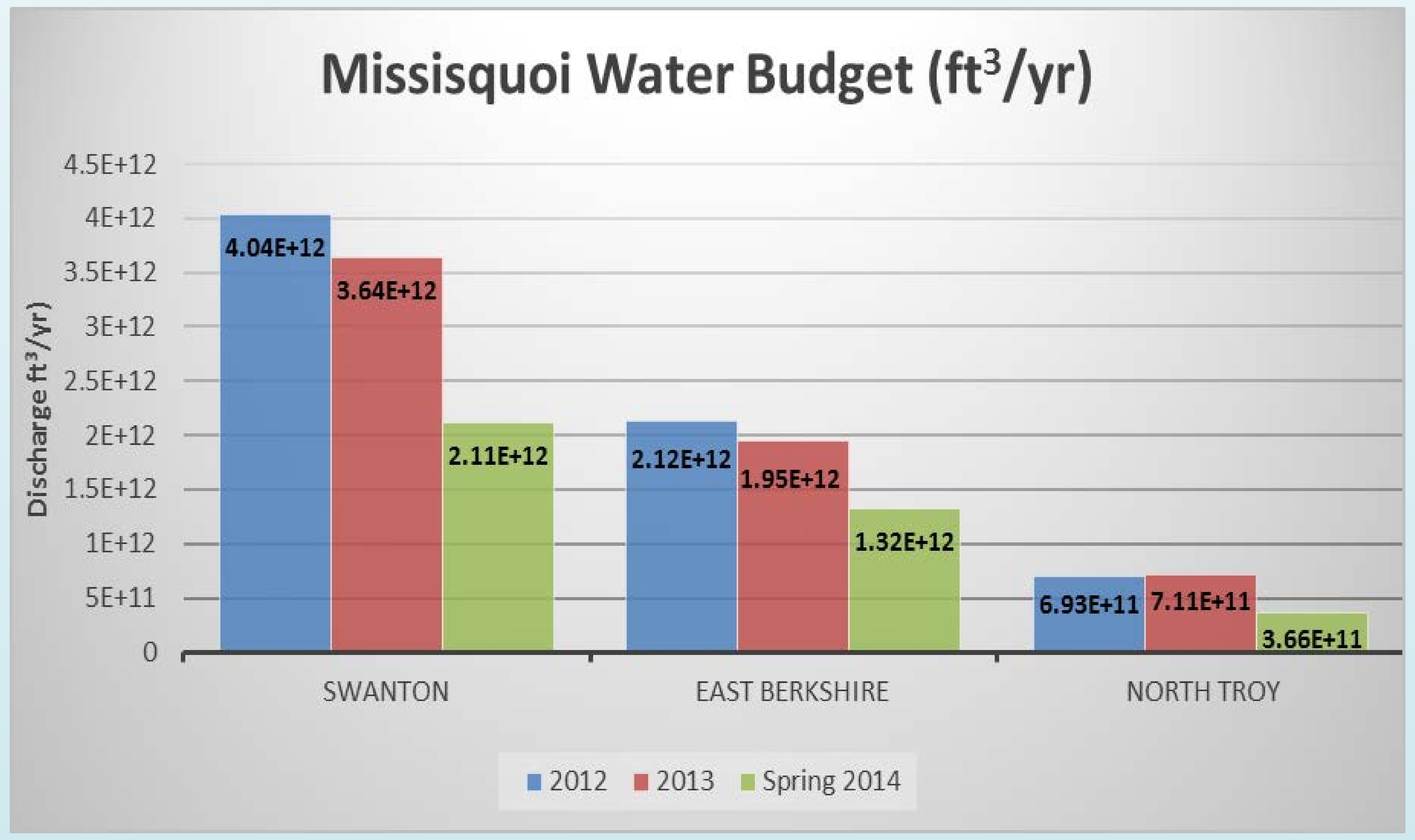

Figure 6: 2012, 2013, and Spring 2014 Missiquoi River Water Budget

Table 2: Spring 2014 Load Estimates for Missisquoi River using Linear Regression Model

Spring 3/30/14-5/1/14	TP Load (kg/yr)	TN Load (kg/yr)	SRP Load (kg/yr)	TSS Load (kg/yr)
Swanton	1.39E+05	6.53E+05	6.77E+03	1.19E+08
Hungerford	5.50E+03	3.14E+04	1.72E+03	1.97E+06
East Berkshire	1.44E+05	4.39E+05	1.02E+04	1.40E+09
North Troy	2.66E+04	1.02E+05	3.47E+02	6.97E+07

- Spring 2014 runoff contributes high TP loadings to the Missisquoi system compared to 2012/2013
- SRP does not have a strong relationship with discharge
- More TP upstream at East Berkshire than Swanton
- Swanton has ~60% higher flow relative to East Berkshire during snowmelt, although East Berkshire has higher comparable nutrient and sediment loads due to a number of dams between East Berkshire and Swanton

Conclusion

There is a strong relationship between higher discharges and larger loadings. The annual loading results using the linear regression and the R Script model are very similar with slight overestimation using the linear regression model, suggesting that the linear assumption is more useful for approximations and comparative purposes, as well as for spring 2014 estimates when the R Script model could not be used due to provisional USGS discharge data.

The hydrographs and water budget for the Missisquoi River shows that spring runoff contributes over 50% of the annual discharge, which corresponds to higher spring nutrient loads. For instance, ~30% of the 2013 annual load came from the spring runoff period. These high spring nutrient loads prime the system for further loading throughout the summer causing harmful algal blooms in Lake Champlain. Nutrient loading generally increases from upstream to downstream, but there is evidence of in stream removal of sediment loading most likely due to a number of dams on the river. This research provides insight for best management practices seasonally and spatially to limit excessive nutrient loading during spring runoff and reduce HAB's in the summer.

Acknowledgements:

I would like to thank funding from NSF, Vermont EPSCoR, *Grant EPS-1101317*, the College of Engineering and Mathematical Sciences, the assistance of the Rubenstein Ecosystem Science Laboratory, Braden Rosenberg, Courtney Giles, Peter Isles, Trevor Gearhart, and Yaoyang Xu.