A Comparison of Ammonium and Nitrate Levels in Forested, Urban and Agricultural Streams Within the Winooski and Missisquoi Watersheds

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Introduction:

- Lake Champlain is a natural, freshwater lake that is surrounded by the northeastern parts of New York and northwestern parts of Vermont. The lake serves as the main tourist attraction to towns like Burlington and Plattsburgh, but up until recently the nitrogen (nitrite and ammonium) levels have been increasing and posing a threat to overall health of the lake.
- Nitrogen is a nonmetallic mineral that is an essential nutrient for the health of any stream or body of water. However, when in excess, it has negative affects to the water quality of any body of water because it promotes excessive plant and algae growth.
- As interns for the Vermont EPSCoR Research on Adaptation to Climate Change (RACC) program we pursued individual research on the comparison of levels of ammonium and nitrate in streams represented by a percent catchment of either forested, agricultural, or urban.
- According to the results of a study published in Catena, NO3 concentrations are much higher in agricultural than forested locations and there is a significant positive correlation between agricultural area and the peak NO3 concentration during rainfall events (Jiang et al, 2012). According to another study, the higher the human and animal population in a specific area, the higher the pollutant concentrations would be, including dissolved nitrogen (NH4 and NO3) (Lang et al, 2013). Based on both these studies, we hypothesize that there will be significant difference between averages of dissolved nitrogen in agricultural sites compared to the urban and forested sites.

Materials and Methods:

- Primary research and sample processing was conducted at labs in both Saint Michael’s College located in Colchester, Vermont and Johnson State College located in Johnson, Vermont throughout the spring, summer and fall months of 2013.
- The water samples were collected using ISCO samplers, which were carefully installed, in eight stream locations throughout Vermont. Locations included Essex, Allen Brook, Mad River, Montpelier, Hungerford, Swanton, East Berkshire and North Troy. Interns were responsible in collecting samples one to three times per week for nutrient and total suspended sediment (TSS) testing throughout the months of June, July and August. Coolers were brought filled with both acid washed and deionized water rinsed ISCO bottles to replace the filled ISCO bottles that were inside ISCO sampler at each of the sites.
- The amount of samples collected were separated into either TSS or Nutrient testing. Nutrient samples were brought to the laboratory in Johnson State College. The nutrient data was analyzed using the standard methods based on the EPA methods 350.1 (NH4) and 353.2 (NO3). The amounts of reagents and volumes used were optimized for the AQ2, which uses smaller amounts of reagents and sample compared to the EPA methods. Distillation of ammonia is not required since water samples were are tested as soon as possible after they are collected.
- Missisquoi River, Allen Brook,, Montpelier, Essex Junction, Mad River, and East Berkshire were the sites that we based our study on.

Results:

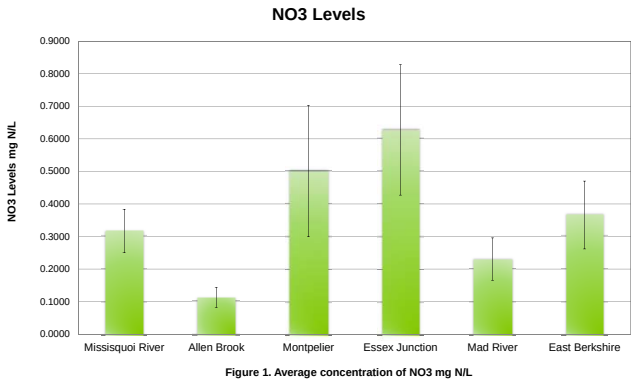

Figure 1. Average concentration of NO3 mg N/L

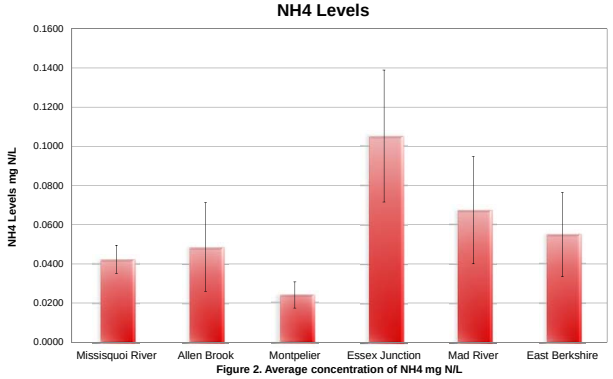

Figure 2. Average concentration of NH4 mg N/L

Table 1. NO3 Analysis of Variance (One-Way)

Summary				
Groups	*Sample size*	*Sum*	*Mean*	*Variance*
Missisquoi River at Swanton	10	3.16891	0.31689	0.04467
Allen Brook	10	1.12717	0.11272	0.00947
Montpelier	10	5.00865	0.50086	0.40568
Essex Junction	10	6.27597	0.6276	0.40088
Mad River	10	2.30646	0.23065	0.04231
East Berkshire	10	3.66158	0.36616	0.10888

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*p-level*	*F crit*
Between Groups	1.71225	5	0.34245	2.03053	**0.08887**	2.94912
Within Groups	9.1071	54	0.16865			
Total	10.81935	59				

Table 2. NH4 Analysis of Variance (One-Way)

Summary				
Groups	*Sample size*	*Sum*	*Mean*	*Variance*
Missisquoi River at Swanton	10	0.42346	0.04235	0.00052
Allen Brook	10	0.4859	0.04859	0.00511
Montpelier	10	0.2409	0.02409	0.00045
Essex Junction	10	1.05248	0.10525	0.01134
Mad River	10	1.94732	0.19473	0.21346
East Berkshire	10	0.54934	0.05493	0.00459

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*p-level*	*F crit*
Between Groups	0.19943	5	0.03989	1.01632	**0.41723**	2.94912
Within Groups	2.11922	54	0.03924			
Total	2.31865	59				

Discussion:

- We chose sites based on their highest percent catchment. Two sites for urban, agricultural and forested. The top five highest levels and the lowest five levels were used for our data analysis. According to ANOVA analysis, there was no significant difference between the Ammonium and Nitrate levels among all six sites. The p-value for the NH4 was 0.41723, which is greater than 0.05. This indicates that the average values between the sites were not significantly different (Figure 1 & Table 1).
- The ANOVA analysis for the NO3 determined a p-value of 0.08887 which is slightly greater than 0.05. This also indicates that the sites were also not significantly different (Figure 2 & Table 2).
- Our hypothesis was not supported. This could be due to low percent land use variables for the urban and agricultural sites.
- Some sites also had negative numbers, which indicates errors. For future studies, it would be interesting to look only at the value of the peaks for each site following an intense rainstorm. We could also repeat this study, but include sites with bigger differences in the percent land use.

Literature Cited:

1. Jiang, R. Woli, K.P. Kuramochi, K. Hayakawa, K. Shimizu, M. Hatano, R. 2012. Coupled control of land use and topography on nitrate-nitrogen dynamics in three adjacent watersheds. *Catena*. **97**:1-11.
2. Lang, M. Li, P. Yan, X. 2013. Runoff concentration and load of nitrogen and phosphorous from a resdential area in an intensive agrcultural watershed. *Science of the Total Environment*. **458-460**: 238-245.

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