Seasonal and Spatial Variation in Surface Water Dissolved Organic Nitrogen at a Permaculture Livestock Farm in Central Virginia

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CONCEPTUAL BACKGROUND

- In analyzing water quality dynamics in inland aquatic ecosystems, dissolved organic nitrogen (DON), including proteins, enzymes, DNA, and various other types of organic nitrogen-bearing compounds, is one of the important factors to consider as it is present in all forms of life. This study focused on the seasonal and spatial variation of surface water DON in the pond and surrounding streams of Timbercreek Farm, a permaculture livestock farm in Charlottesville, Virginia.

- The total dissolved nitrogen (TDN) in the system is made up of both organic (DON) and inorganic (DIN) components (See Equation 1). In this study, inflow and outflow stream sites were analyzed with respect to both DON and DIN.

- Timbercreek Farm is a permaculture livestock farm, meaning that the sustainable farming practices work to mirror natural processes, forming a symbiotic relationship between the land and the livestock (which is the case here are cows, chickens, and pigs).

OBJECTIVES

- In order to better understand DON function and movement through inland lentic ecosystems, this study sought to analyze seasonal fluctuations in DON relative to DIN in the surface waters of the Timbercreek Farm pond. Additionally, DON/DIN regimes were compared between the inflow and outflow stream sites.

- To put this study in a better context, %DON of TDN values were compared to 24 other ponds (at least 4 of which are farm ponds) in the lower %DON (See also Figure 4b). Opposing this trend was DIN, falling in the summer (b).

STUDY SITE AND METHODS

- The surface waters of the pond at Timbercreek Farm were scrutinized for spatial and seasonal DON fluctuations. DON concentrations from inflow Site H were compared to those of outflow Site J. Samples were taken from April of 2015 to January of 2016.

- Samples were collected weekly over the summer of 2015, and biweekly during the academic year, in plastic Nalgene sample bottles.

- The Lachat Automated Ion Analyzer was used to quantify DIN and TDN concentrations in the inflow and outflow sample sites at Timbercreek.

- A persulfate digestion method, followed by Lachat analysis, was performed in order to quantify TDN. Furthermore, by subtracting DIN concentrations from the TDN concentrations, DON values were obtained.

RESULTS

- The inflow exhibited relatively steady DON and DIN concentrations over time, save a drastic DON increase (accompanied by an opposing DIN decrease) on June 6th of 2015. This was linked to a major storm event that took place on that day, with precipitation levels reaching a 5.33 cm (the highest of the entire spring and summer season).

- In the outflow stream (Site J), DON concentrations increased from 10% to 52% of TDN from April to July of 2015, but then decreased from 52% to 14% of TDN from July of 2015 to January of 2016 (See also Figure 4b). Opposing this trend was DIN, falling in the summer and rising again in the fall and winter.

- Although varying to some extent, DON concentrations between the inflow and the outflow were observed to be relatively equivalent over time. The jump in inflow DON on June 6th, 2015 was linked to a major storm event, while the jump in outflow DON from October to November of 2015 was linked to a delayed effect of the accumulation of biomass within the pond over the summer.

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DISCUSSION & CONCLUSIONS

- The most profound conclusion drawn from this study was the explanation of the observed DON fluctuations in the outflow of the pond from Spring of 2015 to Winter of 2016 (Figure 3). In the summer, warmer temperatures and perhaps the development of thermal stratification likely led to characteristically higher epilimnetic primary production rates. This in turn would lead to an accumulation of biomass as microbes convert DIN nutrients, such as NH₃ or NO₂⁻/NO₃⁻ into organic matter (DON).

- It was also determined that storm events drastically increase DON flushing into the system (Inflow, Figure 2).

- Lastly, different agriculture methods have substantial and long-lasting effects on the surrounding ecosystem (shown in the consistently low %DON values of Figure 4).

FUTURE RESEARCH

- Along with the continued inflow and outflow monitoring of DON and DIN, select storm samples will be tested to further analyze how storm events specifically affect DON/DIN fluctuations.

- Additionally, a minimum of 10 other ponds (at least 4 of which are farm ponds) in the Charlottesville area will be sampled and tested for DON and DIN in order to gain a better perspective of the Timbercreek data sets.

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