1. Introduction

High concentrations of nitrate and phosphate in water bodies cause harmful algal blooms, which can be toxic to human and aquatic life. When these algae die and decompose, dissolved oxygen is depleted, and the resulting hypoxic zones affect survival of fish and other organisms. In this study, an agriculture-dominated watershed was compared to an urban-dominated watershed to determine which has a greater contribution of nutrients to the Lower Great Lakes.

The specific objectives were to:
- Observe the effect of discharge on nitrate and phosphate concentration;
- Use major anions to infer the nutrient source;
- Compare mass fluxes for the summer between the watersheds;
- Observe changes in nitrate, phosphate, and dissolved oxygen concentrations throughout the course of a diurnal cycle during baseflow.

2. Field Sites

Nitrate and phosphate can be found in wastewater and in fertilizers used in both urban and agricultural areas. The Tonawanda Creek (Figure 2a) watershed is mostly rural land, and the Scajaquada Creek (Figure 2b) watershed is mostly urban.

Figure 2a: Tonawanda Creek is an agricultural dominated watershed. Samples were collected at the USGS gaging site at Rapids.

Figure 2b: Scajaquada Creek is an urban dominated watershed. Samples were collected at both locations under low flow conditions and, the depth-integrating sampler (right) used at Tonawanda Creek during periods of high flow.

3. Methods

Field Methods:
- Followed USGS sampling guidelines for stream water quality (Shelton, 1994);
- Used appropriate sampling equipment based on stream velocity (Figure 3a);
- Samples were collected and split uniformly (Figure 3b);
- Samples filtered at 0.45 μm (Figure 3b);
- YSI probe used to collect in situ pH, temperature, specific conductivity, and dissolved oxygen;
- Rating curves developed by collaborators (figure 3d) were used to determine discharge at Scajaquada Creek. Discharge data for Tonawanda Creek was taken from the USGS (USGS, 2015).

Lab Methods:
- Determined nitrate and major anions (chloride and sulfate) using ion chromatography (Dionex 1000);
- Total phosphate determined colorimetrically (Genesys-10S) following persulfate digestion according to established procedures (EPA, 1978, APHA et al., 2010);
- Bicarbonate concentration determined by alkalinity titration using a Hach titrimeter.

4. Results

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Figure 4. Major anions plotted on the flow hydrograph for (a) Tonawanda Creek and (b) Scajaquada Creek.

Figure 5. Major anions from Tonawanda Creek taken 6:00 AM to 12:00 PM + 4:00 PM to 7:00 PM under baseflow conditions for 24 hours and 30 minutes. Nitrate and TP measured during the day were plant uptake and 30 minutes measured the DO. The nitrate concentration was constant during each test and there was no change in flow. The nitrate, TP, and DO monitors are not coincident.

Changes over a Diurnal Cycle

Figure 6. Diurnal data from Scajaquada Creek taken 6:00 AM to 12:00 PM + 4:00 PM to 7:00 PM under baseflow conditions for 24 hours and 30 minutes. The nitrate concentration is constant throughout the diurnal period due to no changes in nutrient inputs. The TP concentration is constant due to the loss of endogenous processes acting in the creek. Specific conductance was constant there was no change in flow.

5. Conclusions

- The positive correlation between discharge and nutrient concentration in Tonawanda Creek suggests nutrients are derived from fast flow or overland flow.
- The relationship between discharge and specific conductance in Tonawanda Creek was supported by major anion analysis during both high and low discharge events.
- At Scajaquada Creek no correlation between discharge and anion, nitrate, or phosphate concentrations existed. Nitrate and phosphate concentration at Scajaquada Creek was relatively constant, and not dependent on discharge.
- Mass flux was consistently higher for Tonawanda Creek than Scajaquada Creek for both nutrients. Although limited to only two stream segments, these results suggest that agricultural streams have a higher nitrate and phosphate contribution to the lower Great Lakes than urban streams.
- Diurnal nitrate and phosphate concentration patterns are consistent with plant uptake at Tonawanda Creek. These processes significantly impact nitrate and phosphate concentrations and mass flux at baseflow.

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References


USGS, 2014, USGS 04218000 Tonawanda Creek at Rapids, NY:


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ecosystem restoration through interdisciplinary exchange

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