Phosphorus Loading in Ten Tributaries of the Lamoille River Basin

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Introduction

The Lamoille River of northern Vermont is one of Lake Champlain's largest contributors with a length of 85 miles and a drainage area of approximately 706-mi^2. As a large body of water in the United States, Lake Champlain has been experiencing algal blooms and other water quality issues for the past couple decades due to an increase in nutrient loading from its tributaries. Nutrients, including nitrogen and phosphorus, promote the growth of harmful algae and bacteria, like *E. coli*.

These nutrients have been attributed to point and nonpoint sources, such as stormwater runoff over agricultural and impervious lands and the erosion of stream banks and dirt roads. There are many ways to improve these areas to decrease the amount of runoff contributing to the eutrophication of Lake Champlain. VT EPSCoR's RACC provided the opportunity to study and analyze the tributaries of one of Lake Champlain's greatest tributaries, the Lamoille.

The purpose of this study was to quantify the mean Total phosphorus (TP) loading (mg/sec) for each studied tributary of the Lamoille for the last five years by utilizing each tributary's discharge levels and TP concentration measurements.

Methods

For 6 years, 19 stream sites in the Lamoille River Basin have been studied through the summer months. During storm events, constituted by steady precipitation and a rising hydrograph, researchers measured the discharge (m^3/sec) of the water, and assessed the water chemistry for TP levels.

Utilizing the U.S. Geological Survey's (USGS) Lamoille gauge data, the Lamoille discharge was graphed comparatively to the tributary discharge for each measurement day. From this graph, unmeasurable high-flow days were predicted using regression lines. The USGS gauge data was also used to determine which sample days had occurred during a peak hydrograph event. Peak hydrograph events correlate to both high flow and high nutrient levels.

To calculate TP loading, the tributary discharge measurement (m3/sec) had to be converted to liters per second. The product of the TP concentration (mg/L) and discharge (L/sec) provided total TP uploading, for each measurement taken during a storm event for the last five years. Finally, mean TP loading could be determined for each stream site by taking an average of each site's total TP uploading values.

Results

- 19 storm events were examined with none occurring in 2009 or 2012.
- The sites with moderate to high discharge levels and reasonable TP concentrations had the greatest TP loading measurements. See figure 1.
- The more agricultural land present in the tributary's catchment corresponds to a greater amount of TP. See figure 2.
- The more forested land present in the tributary's catchment corresponds to a lesser amount of TP. See figure 3.

According to Cohen (1988), a small effect size is r^2=0.01, a medium effect size is r^2=0.09, and a large effect size is r^2=0.25.

This being said, there is a medium effect size for the correlation between mouth sites, TP loading, and the percent of forested land in a catchment area 1-mile upstream; r^2=0.10.

There is a large effect size for the Relationship between upstream sites, TP loading, and the percent of forested land in a catchment area 1-mile upstream; r^2=0.65.

There is also a large effect size for the correlation between TP loading and the percent of agricultural land present in the catchment area; r^2=0.285.

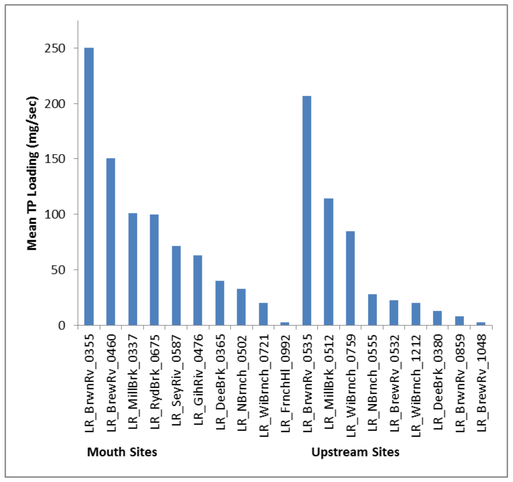

Figure 1. TP Loading into Lamoille from Stream Sites

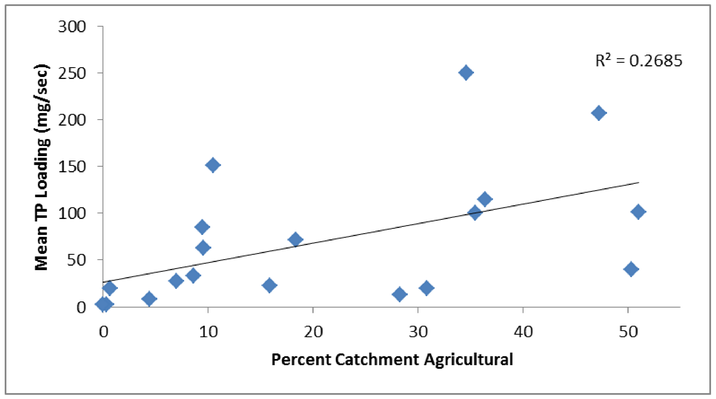

Figure 2. TP Loading for Agricultural Land in Catchment 1-mile Upstream

Figure 4. Measuring Baseline Stream Flow

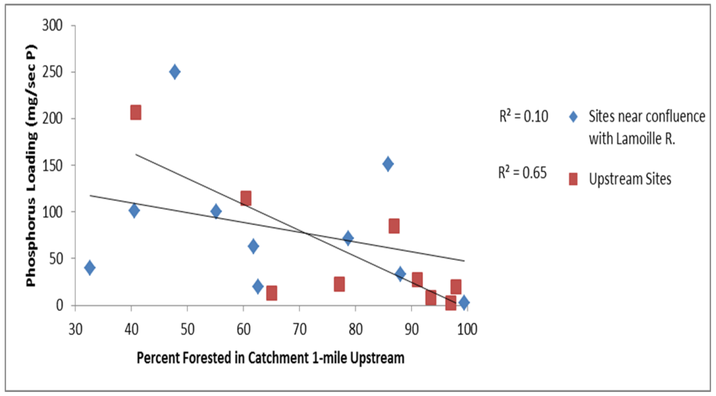

Figure 3. TP Loading for Forested Land in Catchment 1-mile Upstream

Discussion

The data shows a relationship between the land use of the catchment areas and TP loading where the more agricultural areas result in those tributaries having higher measurements of TP and the more forested areas having tributaries with lower TP measurements. It is possible to make a broader statement about the anthropogenic effect as increased agricultural land and urbanization increases the amount of point and nonpoint sources contributing to the excess of nutrients flowing into the Lamoille, and ultimately, Lake Champlain.

With this in mind, the Lake Champlain Basin Program (2009), "has identified phosphorus reduction as one of the highest environmental management priorities for the lake," and Medalie and Smeltzer (2004) noted that this, "has been a priority of Vermont, New York, and Quebec since 1990." With the future in mind, many changes, such as more governance and best management practices by stakeholders, should be made to better manage high nutrient levels, and benefit the health of Lake Champlain.

These advances towards the bettering of the Lake Champlain ecosystem are necessary but can only be accomplished one step at a time. This research helps to quantify the impact, in terms of TP loading, each tributary of the Lamoille River is having on Lake Champlain.

Literature Cited

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