Changes in total soil phosphorus from field to stream bank in the Missisquoi Watershed

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Background

Nutrient loading, particularly that of phosphorus (P), into waterways in the Lake Champlain Basin is a major contributing factor to toxic algae blooms in our rivers, lakes and streams, and an ongoing threat to the surface waters of our region and related ecosystems. While riparian buffers along agricultural fields in stream corridors offer some protection from soil erosion and P runoff, an estimated 75% of Vermont's stream banks are still subject to erosion due to floodplain loss (VT DEC 2007), and exist as a major source of non-point P pollution. A greater understanding of the processes by which P is able to move from fertilized agricultural fields towards these compromised stream banks over time is of great importance in our efforts to understand, map and track non point pollution sources in Lake Champlain and the surrounding watershed.

Objectives

To answer the following questions:

- *How does nutrient status change within a transect from corn to stream bank?*
- *How does nutrient status change with soil depth?*
- *Is there evidence that phosphorus or nitrate are moving laterally towards the stream from fertilized fields?*
- *Is there evidence that either is moving downward through the soil profile towards ground water?*

Methods

- *With the cooperation of crop consultants and dairy farmers, located transects in corn fields along stream banks of the Missisquoi river and its tributaries*
- *3 points sampled within each transect*
    - *1 m from stream bank edge*
    - *Halfway through riparian buffer*
    - *5 m into corn*
- *4 depths: 0-15 (plow layer), 15-30, 30-60 and 60 -90 cm*
- *Wherever possible, also obtained bank samples at 1 m intervals*

Lab Tests

- *All soils air dried, sieved through 2 mm screen and ground to finer than 0.5 mm for total P analysis*
- *Total P was measured by nitric acid microwave assisted digestion and ICP-AES analysis*
- *Standard soil reference materials from the North America Proficiency Testing program were used for quality assurance*

Statistics

- *A full factorial analysis of variance (ANOVA) was performed using field, position-in-field and depth. The three way interaction was highly insignificant and was dropped from the model.*
- *Because a stream bank samples were not able to be taken from every transect, these were not included in the statistical analyses.*

Results

- *18 transects were sampled in four fields from three active dairy farms*
    - *18 transects x 3 points x 4 depths = 216 samples*
    - *30 bank samples (not all transects had bank samples)*

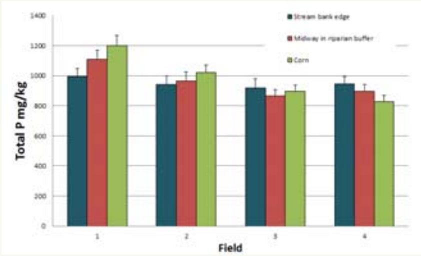

Figure 1. Mean concentrations of total P for all depths (0-90 cm) from stream bank edge to corn.

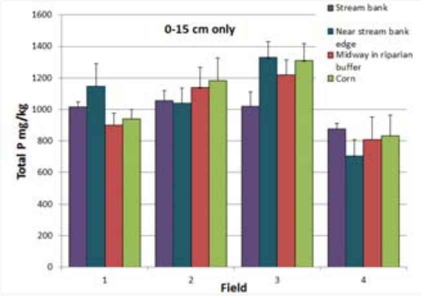

Figure 2. Mean total P concentrations for eroding stream bank walls, as well as plow layer of stream bank edge to corn.

References

- *Publication on nutrient recommendations for field crops in Vermont:* http://pss.uvm.edu/vtcrops/articles/VT_Nutrient_Rec_Field_Crops_1390.pdf
- *Publication on soil test procedures used in the Northeastern US:* http://extension.udel.edu/lawngarden/lawn-garden/soil-health-composting/reccomended-soil-testing-procedures-for-the-notheastern-united-states/

Conclusions

While no obvious trends emerged across all mean total P levels, statistical differences between fields and soil profile depths were present and offer opportunities for further research. Significant differences were found between fields 1, 2 and 3 (no difference between 3 and 4), and mean plow layer P for combined fields was significantly higher than in lower depths. No difference was found between locations (stream bank edge, riparian buffer, corn) when comparing combined means for all fields. All mean total P concentrations for the four fields sampled were considerably higher than those found in previous P studies conducted in the Missisquoi Watershed. Further lab testing will allow us to characterize these higher P values as naturally occurring or the result of repeated manure/ fertilizer additions.

In related studies, testing of the same samples revealed statistical differences in nitrate and soil test P concentrations between position, field and depth, with concentrations trending higher in corn vs. stream bank edge as well as higher in plow layers vs. lower soil profile depths.

Future work

Through continued lab testing, we hope to further speciate the forms of organic P present in these soils. We aim to gain a greater understanding of the origin of soil nutrients in each field, their movement to stream water, and ultimately into Lake Champlain.

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