Degree of Phosphorus Saturation: A Comparison Between Mad River and Hungerford Watersheds

María Del Mar Díaz Bonilla, Donald Ross
Vermont EPSCoR, University of Vermont, University of Puerto Rico

Introduction

Phosphorus (P) is a key nutrient for plant growth. If found in excess due to fertilizers, it will load on tributaries of watersheds, such as Mad River and Hungerford, which in turn release into Lake Champlain. These high concentrations of P have caused an impact on water quality because of algal growth. These blooms contain high bacterial populations and deplete the oxygen available. Hypoxia in waters results in poor conditions for aquatic life, leading to biodiversity loss and risk of toxins released by algae. Efforts have been made to track the sources of P excess and to develop effective management plans. The Degree of Phosphorus Saturation contributes to such efforts: as its value increases, so does the risk of P losses from soils to waters when soil can no longer absorb P (Allen and Mallarino, 2006). Therefore, the risk of eutrophication can be estimated by knowing the quantities of actual P that have the potential of being released from lake sediments onto aquatic systems.

Objectives

1. Study the relationships between:
   a. DPS and depth in stream bank edge
   b.DPS and distance from the stream bank edge at 0-15 cm of depth

2. Determine which of the 2 watersheds (Mad River or Hungerford) contributes more to P loading onto Lake Champlain.

Methods

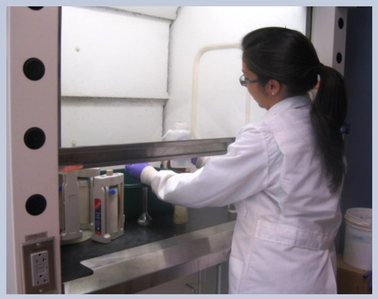
In the Field

Two transects (4 m apart) were measured:
- 1 m from stream bank edge
- Midway from riparian buffer
- 10 m into field

4 depths were obtained: 0-15 cm, 15-30 cm, 30-60 cm, 60-90 cm.
Satellites were taken at 10 m intervals of each location; bank samples, whenever available at 0 m, 1 m, and so forth.

In the Lab

•Samples were air dried, sieved through 2 mm screen.
•For Total P: ground to finer than 0.5 mm for the nitric acid microwave assisted digestion.
•For oxalate extraction: ground to finer than 0.25 mm, 0.5g of chosen sample were added 20 mL of 0.2 *M* acid ammonium oxalate solution, (NH4)2C2O4·H2O. Sample tubes were shaken horizontally for 4 h in the dark, centrifuged for 10 min at approximately 1520 g. Clear supernatant was decanted into ICP tubes.
•All samples were analyzed with Induced Coupled Plasma spectrometer.



Results

Two Watersheds were sampled:
- 9 Mad River tributaries
- 5 Hungerford tributaries

Averages were made for each depth and location.

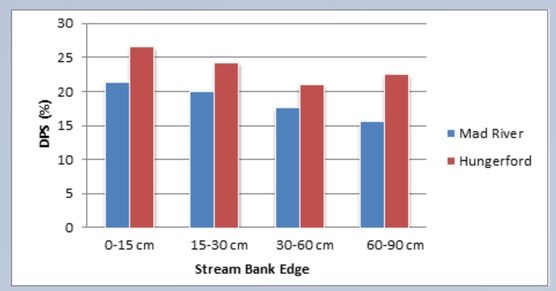


Figure 1. DPS by watershed and depth (data from stream bank edge only).

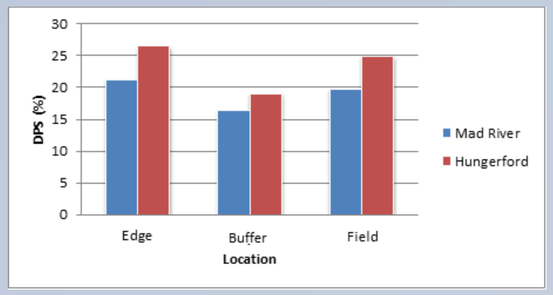


Figure 2. DPS by watershed and location (data from 0-15 cm in depth only).

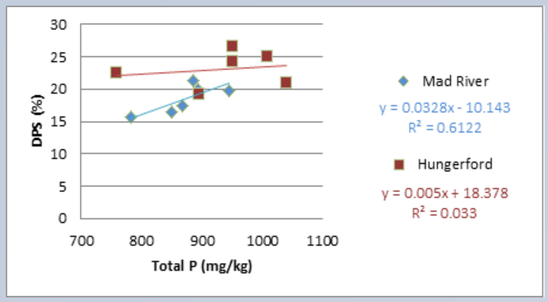


Figure 3. Relationship between DPS and Total P for both watersheds.

Conclusion

Overall the results showed three trends:

•Higher DPS in the top layer, decreasing with depth.
•Higher DPS within fertilized fields, decreasing with distance from fertilized area towards stream.
•Positive relationship between DPS and total P in the Mad River watershed

All could be attributable to the additions of fertilizers and manure in the plow layer, since as more total P is added to the soil, extra P is fixed, which promotes the increase of DPS. When its value is >10%, the probability of P desorption increases (Hooda et al., 2000). As for Hungerford, the relationship between DPS and total P was negative. This was unexpected since agriculture in this area is more active. Nonetheless, the DPS was higher for this watershed, suggesting higher P loading onto streams than Mad River.

Further studies should be conducted, but these results on DPS can confirm that the use of fertilizers and manure to agricultural fields increases the risk of P desorption to surface waters. Improved agricultural management practices are necessary for the stabilization of phosphorus levels in Lake Champlain.

Literature cited

Allen, B.L. and Mallarino, A.P. (2006) Relationships between extractable soil phosphorus and phosphorus saturation after long-term fertilizer or manure application. Soil Science Society of America Journal 70(2), pp. 454-463.

Hooda, P.S., Rendell, A.R., Edwards, A.C., Withers, P.J.A., Aitken, M.N. and Truesdale, V.W. (2000) Relating soil phosphorus indices to potential phosphorus release to water. Journal of Environmental Quality 29(4), pp. 1166-1171.

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