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Trapping phosphorous from agricultural catchments by using bioreactors with calcinated eggshells and woodchips

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Eutrophication is an environmental issue in the Great Lakes region caused by excess phosphorous (P) input from the watershed to receiving waterbodies and reduces water quality, e.g. harmful agal blooms. One such watershed, the Bay of Quinte, is a eutrophic embayment of Lake Ontario, Laurentian Great Lakes system. The remediation plan for the Bay of Quinte has highlighted the need for remediation technologies to treat phosphorous (P) from agricultural runoff in the watershed. The overall target of remediation work in the Bay of Quinte is a 20% average reduction in agricultural P, or a 20 ug TP/L (flow weighted) growing season average. Despite targeted remediation efforts the P reduction in watershed has failed to meet flow rated targets. It has been suggested that greater runoff containing particulate P during extreme precipitation events may be the driving factor. Such extreme events are likely to increase in frequency as a result of climate change. Thus, further remediation action is required.

In this study, we propose using calcinated eggshell and woodchip bioreactors at key locations to reduce and even re-use P from agricultural runoff. The main objectives of our study were development and scaling up of the bioreactor technology, and implementation of this technology. In the bioreactors calcined eggshells are a desirable substrate as the calcination process converts $CaCO_3$ within the eggshells to CaO increasing porosity and the surface area, and consequently, promotes adsorption. Additionally, CaO has a high affinity to PO_4^{3-} , forming hydroxyapatite, a refractory P phase. The secondary substrate, woodchips, stimulates denitrifying microbes (1). In our work we also conducted batch removal and adsorption experiments with calcined eggshells. The eggshells remove up to 80% of dissolved P with as little as 2-3 total weight% in only 8 hours. After batch experiments were completed a flow-through benchtop bioreactor was also created and natural agricultural runoff was treated. Similar removal results were observed showing that this technology is viable. The next step of our project is an implementation the bioreactors at an active farm.

References:

1. Christianson, Laura E., et al. "Denitrifying woodchip bioreactor and phosphorus filter ..." *Water research*121 (2017): 129-139.