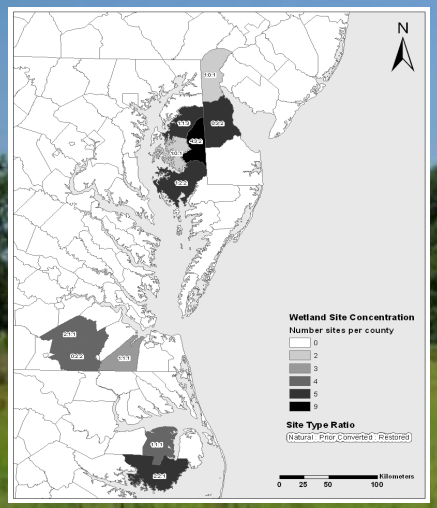
Controls on Soil Phosphorus in Native, Disturbed and Hydrologically Restored Agricultural Wetlands

Clinton D. Church[1], Peter J. A. Kleinman[1], Megan Lang[2], Jarrod O. Miller[3], and Lou Saporito[1]

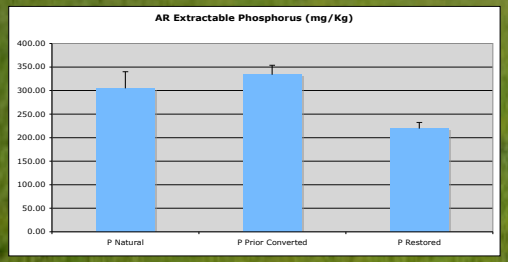
[1]USDA-ARS, University Park, PA: [2]USDA-FS, Beltsville MD; [3]USDA-ARS, Florence SC

Introduction

Restoration of wetland function is a priority emphasis of watershed programs aimed at improving water quality. The efficiency of newly created or restored wetlands to assimilate phosphorus (P) has been tied to the properties and maturation of wetland soils. Soils from 48 wetlands were sampled and analyzed for an array of P properties to elucidate their efficiency to retain P.

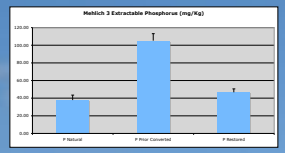


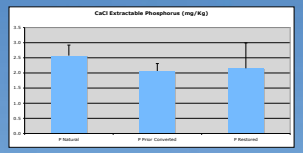
Total P



Total P (aqua regia extractable) was lowest in restored wetland soils, but not significantly different in prior converted (currently farmed) wetland or natural wetland soils.

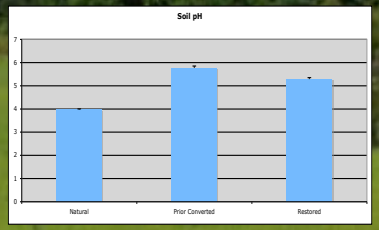
Agronomic and Dissolved P

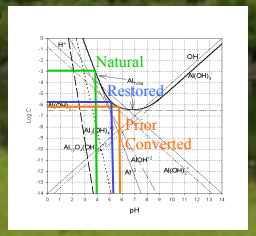




A history of fertilizing the agricultural soils, particularly with manure, has increased their crop available P. While this is an agronomic objective, concentrations in agricultural soils are well above crop sufficiency requirements. Despite the differences in agronomically available P (shown above left), the amount of calcium chloride soluble P, well correlated to dissolved P that is available to runoff water, did not differ significantly across the alteration gradient.

Soil pH and Aluminum Solubility

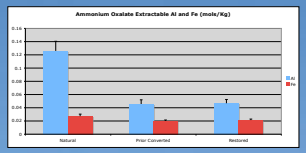


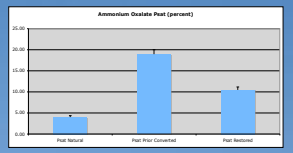


Soil pH offers insight into the discrepancy between water soluble (weak salt extractable) P trends and agronomic P trends. The greater pH in the "prior converted" soils reflects liming as part of standard agronomic management. This liming had profound effects on the solubility of aluminum (> 3 orders of magnitude). Aluminum is a key component of the P sorption capacity of the wetland soils, and many studies have shown that it is the sorption capacity of wetland soils that determines their effectiveness in removing (mitigating) dissolved P.

Restoration at these sites generally involved scalping of surface soils, removing some of the limed soil. Removal of the top soil during restoration exposed soil that had a lower pH and greater soluble aluminum concentration. However, the pH was lowered by less than one unit, and not returned to native conditions.

P Sorption Capacity of Soils





The P sorption capacity of wetland soils, as represented by amorphous Al and Fe, is severely reduced in prior converted and restored soils. The primary difference between native and disturbed sites relates to oxalate extractable Al, probably due to the lesser solubility in agricultural and restored soils. The consequence of this discrepancy between native and disturbed sites is best seen in the P sorption saturation (Psat) values. P sorption saturation is one of the most robust indicators of environmental availability of P. Here, it is clear that the restored sites have P saturation values well above natural conditions. Thus, while P saturation values of restored soils are half of the "prior converted sites" there is still potential for them to be substantially lowered.

Conclusions

Results point to significant differences in soil P by wetland category within certain geographic areas. Total P was lowest in restored wetland soils, but not significantly different in currently farmed wetland or native wetland soils. Despite the similarity in total P, oxalate extractions revealed that agricultural soils were significantly more saturated with respect to iron and aluminum than either of the other two soil types, while the native wetlands soils were the least saturated, and thus, better able to retain P.

Contact Information

For questions or discussion please contact:
Clinton D. Church, USDA-ARS
Building 3702, Curtin Road
University Park, PA 16802
Phone: 814-863-8760
Email: Clinton.Church@ars.usda.gov