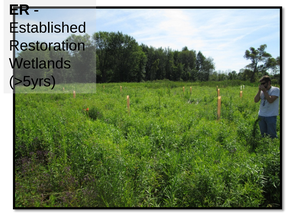
Dynamic Soil Properties – Organic Soils in Restored Wetlands

12-GRR MLRA Soil Survey Office in Grand Rapids, MI

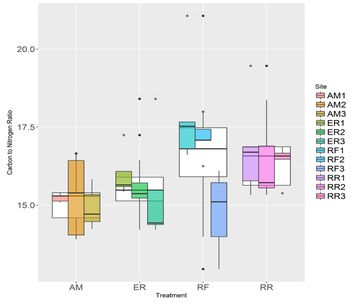
Background

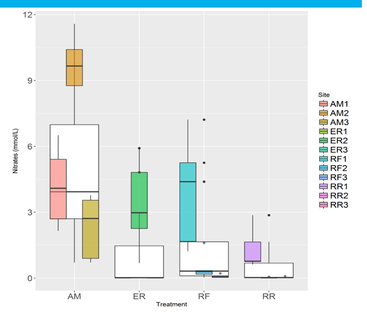
The efficacy of wetland restoration on soil health is not well known. In order to assess this, we collected and compared dynamic soil property (DSP) data of histosol soils in central Lower Michigan (MLRA 98) for four land use treatments: actively farmed (AM), recently restored wetland (RR), older restorations (ER), and relatively undisturbed hydrology and vegetation (RF). Each of these four treatments were replicated among 3 sites, and within each site we dug 5 pits. Samples were collected from each horizon to a depth of 200 cm for a center pedon and 100 cm for the four satellite pedons. Samples were analyzed by Kellogg Soil Survey Laboratory for bulk density, nitrogen, carbon, nitrates, phosphorous, electrical conductivity, pH, exchangeable cations, and soil enzymatic activity. In addition to soil data, vegetation was quantified by plant species at each site.

Definitions of Treatments

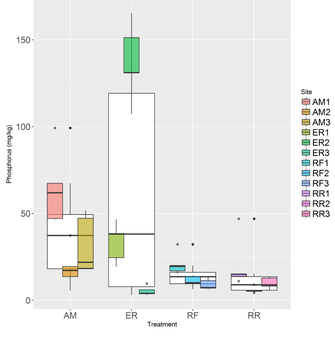


Carbon to Nitrogen Ratio and Nitrate in upper 50 cm by Treatment/Site

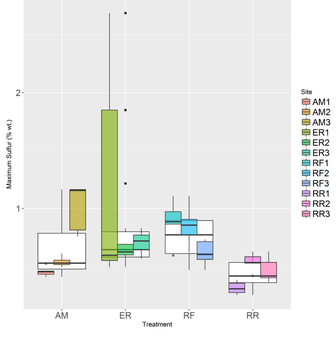




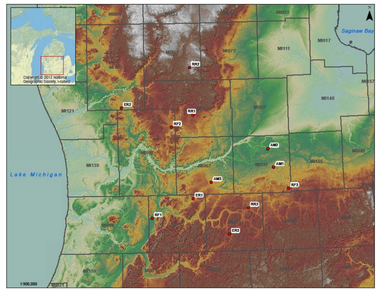
Total Phosphorus Content in Upper 50 cm

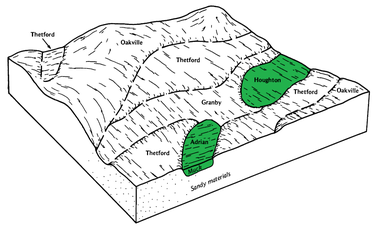


Maximum Sulfur Content in Upper 100 cm

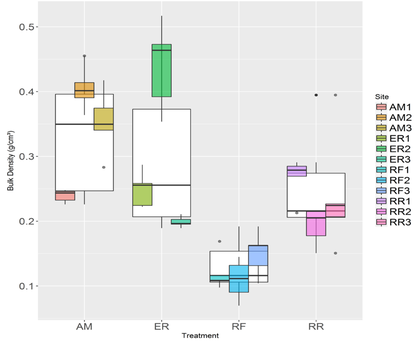


Map of Site Locations and Block Diagram of Typical Landscape



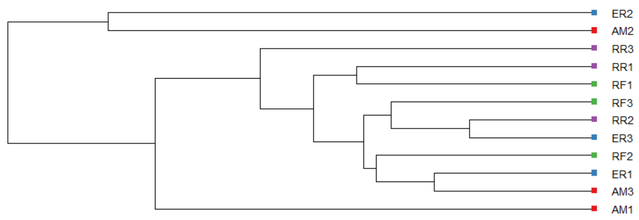


Bulk Density in Upper 50 cm by Treatment/Site



Relationships Among Sites Based on Abiotic Properties

Cluster analysis based on a distance matrix of chemical and physical soil properties. Site relationships do not closely correspond to treatment.



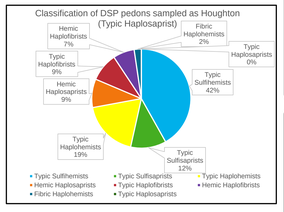
Soil Taxonomy Findings

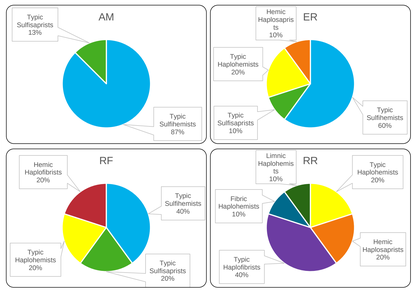
Fiber Content

- Lab results indicate higher fiber content than field estimates, and commonly resulted in soils sampled as Saprists to classify in the Hemists suborder.

Sulfidic Materials

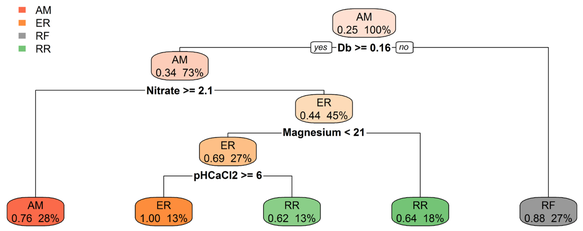
- Before this study, sulfur content had not been examined for histosols mapped in Michigan. A majority of the sampled pedons had horizons within 100 cm that met the taxonomic definition of sulfidic materials and thus classified as either Sulfihemists or Sulfisaprists.



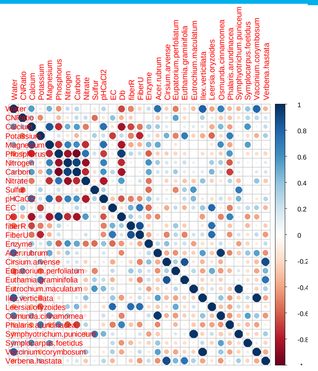


Classification Tree of Abiotic Properties by Treatment

Classification tree which sorts treatments based on chemical and physical soil properties. Properties that best differentiate the treatments are displayed at each node. The decimal in each box is the likelihood for the displayed treatment at each point in the sorting process. The percentage in each box indicates the sites remaining after each sort.



Correlation Matrix



Graphical representation of the correlation between variables. Large blue dots symbolize the highest positive correlation and large red dots indicate highest negative correlation. For example, note the association of high nitrates and bulk density with the presence of Phalaris arundinacea (reed canary grass).

Conclusions

Among the dynamic soil properties, nitrates, phosphorous, carbon to nitrogen ratio, bulk density, electrical conductivity, calcium, and magnesium had significant relationships with treatment. Enzymatic activity was not affected by treatment. Draining and farming wetlands increases soil bulk density, nitrates, and phosphates, while it decreases electrical conductivity, calcium, and magnesium. The RR sites were more successful than ER sites at restoring dynamic soil properties, despite being more recently restored; but neither treatment was as wet as the reference. The abundance of invasive *Phalaris arundinacea* (reed canary grass) in the restored sites was not related to treatment, but was associated with higher nitrates and bulk density. Decades of tree development are required before restored sites resemble reference vegetation.

Limnic material, dominantly marl, was much more common than current map unit descriptions suggest. These areas were avoided in the early stages of the project when sites were being selected. One possible explanation for this discrepancy may have been the use of small diameter (2.5 cm) soil probes during initial mapping. In our experience, marl was not retrieved from lower in the soil profile as effectively with probes as it was with the peat sampler we used during our site selection. We recommend the use of peat samplers during future field-based updates of histosols.

Microtopography in swamps was mostly ignored during this project. Current map units make no distinction between the micro-lows and micro-highs, but this may warrant further examination in future update projects. Soil sampling focused on the "matrix" of these map units which was dominantly flat. The height of hummocks and other microtopographic highs were measured, but were not sampled. Vegetative inventories covered the full range of highs and lows within the plot area.

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