Monitoring Trends in Soil Phosphorus through Conversion of Cropland to Prairie on the former Acker Farm

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Soil phosphorus (P) levels on cropland on the former Acker farm are very high: in 2016, area-weighted mean Bray P was 318 parts per million (ppm), with a range of 216-550 ppm among fields. For reference, optimal soil P for growing corn is 30 ppm. The high soil P levels probably accumulated over many decades of manure applications whose P content exceeded crop needs. High soil P leads to high P concentrations in runoff, which contributes to eutrophication of the Yahara Lakes.

One of the goals of restoring the farm to prairie is to reduce P transport to the Yahara Lakes. Reductions in P transport can be achieved by reducing runoff volume and/or by reducing P concentration in runoff. Prairie restoration is expected to reduce runoff volume by promoting rainfall infiltration. Prairie restoration may also reduce P concentration in runoff by shifting hydrology from surface to subsurface flow, which causes less erosion; by reducing runoff velocity, which promotes settling of particulate P; and by vertical redistribution of soil P by perennial vegetation. Unless prairie vegetation is harvested and taken offsite, it is unlikely that soil P will decline very much, except that some P will leave the site in runoff and no new P will be applied. However, rainfall infiltration and runoff detention in constructed wetland basins are expected to significantly reduce downstream P transport even if soil P does not change.

The goal of this study is to describe changes in soil P following restoration of cropland to prairie on the former Acker farm. According to Laura Ward Good (UW Soils Dept.) and my own brief literature review, there have been no published studies of trends in soil P following restoration of cropland to prairie. Soil sampling will follow UW Extension guidelines for grid-point sampling (Peters and Laboski 2013). With this method, each field is divided into a 5-acre grid, and within each grid cell, a random point is selected (Figure 1). A grid-point sample consists of at least 10 6-inch-deep cores collected from random locations within a 10-foot radius around the point. To assess P stratification, each core will be divided into the top 2 inches and the bottom 4 inches. The top and bottom sections are then composited separately, created a single top sample and a single bottom sample for each point. Sampling will be conducted in the fall every year for the first four years and then may be reduced to every other year if inter-annual variability is low compared to expected long-term changes. Soil samples will be analyzed for Bray P by the UW Soil and Forage Laboratory in Marshfield and for total P by the Wisconsin State Lab of Hygiene.

After roughly ten years, trends in soil P will be assessed with a mixed effects model, with soil P as the response variable, random effects of grid point on the intercept and slope of year, fixed effect of sample depth, and a possible fixed effect of elevation as an indicator of landscape position. Ideally, the study would continue for the foreseeable future to assess the long-term effects of this restoration.

Figure 1. Proposed sample grid and points for the Acker farm. Field boundaries were buffered in by 30 feet to avoid possibly atypical soil conditions. Fields were then trimmed to exclude areas in the permanent pool of the wetland basins. Remaining areas were then divided into approximately equal areas no greater than 5 acres by hand digitizing. Sample points were created in each grid cell with the Create Random Points tool in ArcGIS.