Soil and Groundwater Dynamics Within Varying Land Classes of a Proposed Forested Wetland Mitigation Bank

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Wetland mitigation programs aim to reduce impacts from the permitted destruction of wetlands by preemptively creating, restoring, enhancing, and preserving wetland structure and function within "banks" located in similar ecological boundaries. Research has revealed numerous positive benefits of mitigation efforts, but gaps remain in our understanding of comparable biogeochemical functionality between natural and restored wetlands, particularly within forested riverine wetlands. Several active mitigation projects within the Army Corps of Engineers New Orleans District claim improved biogeochemical functionality from created, restored, or enhanced wetlands without adequate assessment of pre and post functionality. Here, we demonstrate soil and groundwater functional analyses prior to vegetative and hydrologic restoration in a proposed mitigation bank located within 3 km of the Mississippi River near St. Gabriel, Louisiana. Local precipitation currently drives hydrologic dynamics in the bank whereas seasonal river flooding was the former driver prior to construction of protection levees. In and around the bank, we assessed bulk density, organic matter, pH, and nutrient distribution (P, K, Na, S, Zn, Ca, Cu, Mg, total N, total C) in soil profiles of varying land classes at 15 systematically placed sites with 5 randomly spaced sampling subsites. At each site, we monitored groundwater to 2 m depth weekly. Land classes included bottomland hardwood forest, cattle pasture, row crop, and revegetated pasture. Soil deposits included rarely flooded Sharkey clays with some frequently flooded Sharkey clays and Commerce silt clay loams. Soils were sampled at 0 – 10 cm, 10 – 20 cm, and 20 – 30 cm profiles. We hypothesized that bulk density of the upper profile would be lowest in the forested land class due to increased organic inputs and highest in the cattle pasture due to trampling and compaction. This hypothesis was correct and only the top profile of the revegetated pasture had similar bulk density to the forested sites. We also anticipated C/N ratios to be highest in the forested and revegetated areas with greater inputs of dead plant material and lowest in the cattle pastures and row crop land classes. This hypothesis was correct with the lowest C:N ratios in the row crop land class. We expected nutrient content to have a negative relationship with elevation. This hypothesis was correct as nutrients filter downslope. The highest concentrations of Ca, Cu, Mg, K, Na, and S were found in the forested land class. Finally, we expected more seasonally responsive groundwater dynamics in the forested areas than pasture lands, though we did not observe this relationship. These baseline estimates reveal potential benefits of restoring pastureland or row crops to bottomland hardwood forest, such as increased soil nutrients and quality. We propose incorporation of these pre-restoration functional assessments into wetland credit valuation, and we advocate for more comprehensive long-term monitoring of biogeochemical functions within wetland mitigation banks to ensure 1:1 replacement of wetland value.