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Interpreting Morphological Features in Wetland Soils using Hydrologic Models

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Soil morphological characteristics such as redoximorphic features and hydric soil field indicators form under saturated and anaerobic conditions, but the exact hydrology needed to form these features is generally unknown. This review will illustrate how long-term soil hydrology can be determined with a simulation model, and will then show how the results can be used to define the hydrologic requirements needed to form selected soil morphological properties. Studies in NC have calibrated the water-table simulation model DRAINMOD to soil conditions at a number of sites with hydric soil field indicators. Long-term rainfall data were used with the calibrated models to compute 40-yr of daily water table data to represent both wet and dry years. This calibration procedure was performed on five sites that collectively contained soils ranging from Aquic Paleudults to Typic Haplosaprists. Results showed that Histosols were ponded each year for average periods of 110 d, with cumulative ponding events lasting 10 months per year. Soils with histic epipedons were continuously ponded for shorter (15 d) periods, but water tables were within 30 cm of the surface for an average period of 7 months per year. Mineral soils with umbric surfaces (formed by organic C accumulation) were not ponded annually, but water tables were within 30 cm of the surface for 4 months per year. Field indicators consisting of redoximorphic features (a depleted matrix), with no appreciable accumulation of organic C, were saturated on average for 3 continuous months per year. These results can be used, within this region, to evaluate long-term soil hydrology simply by identifying the type of morphological field indicator present.

Wetland restoration is a growing industry in the U.S. but little hydrologic information is available to guide botanists and engineers in their restoration projects. Wetlands that were drained can be restored by recreating the hydrologic conditions necessary to

grow a specific plant community. A plant community consists of a mixture of trees and shrubs that grow together within a limited range of ponding durations and water table depths. Using the techniques described earlier, we evaluated the hydrologic needs of four plant communities used for wetland restoration: pond pine woodland, nonriverine swamp forest, bay forest, and pocosin. Over a 40-yr period, the pond pine woodland required short ponding events (15 d long), but the water table was within 15 cm of the surface for 7 months of the year. The bay forest, nonriverine swamp forest, and pocosin plant communities had similar hydrologies where soils were ponded for up to 10 months per year. Nonriverine swamp forest grew where soil P levels were significantly higher than the other two communities. Pocosin communities were in areas of disturbance, while the bay forest grew where soil P levels were low. These data can be used by engineers to configure the wetland restoration site to achieve a hydrology that supports the target plant community.

Relict redoximorphic features formed in soils that were saturated and reduced at some time in the past, but occur today in soils whose hydrology was altered to make the soils drier. Long-term hydrologic simulation data can be used to determine if redoximorphic features reflect current or former hydrologic conditions. We have found that redox depletions persist in soils once they are formed, and that some features may develop during saturation events that occur rarely, such as once every 10 yr on average. Such features may not be relict, but simply ones that result from large rainfall events that do not occur every year.

Redoximorphic features form in soils that are saturated and anaerobic when iron reduction occurs. Hydrologic models can be used to estimate the durations of anaerobic conditions, but the time required for a saturated soil to become anaerobic or Fe-reduced must first be known. In the southeastern U.S., soil temperature does not strongly control when soils become anaerobic because soil microbes respire year-round. We have shown that when soil organic C levels are greater than 0.03 g/g a saturated soil will become anaerobic in about 3 d. Where organic C levels are less than 0.03 g/g, then anaerobic conditions develop after 3 to 50 d of saturation, with longer times needed as the organic C level decreases. These data show that longer periods of saturation are needed to form redoximorphic features as organic C levels decrease. When organic C concentrations are low, horizons may be saturated for periods up to 3 weeks without any redoximorphic features being present. Thus, redoximorphic features don’t show the depth of the seasonal high water table, rather they show where the soil has been saturated long enough anaerobic conditions to develop.