

Factors Impacting Nitrate-N Removal by Wetlands Placed Using LiDAR

Topographic Data: A Watershed-Scale Modeling Exercise

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Abstract

Mitigating Gulf of Mexico hypoxia will require practices to reduce nitrate losses from tile drained watersheds across the US's upper Mississippi River basin. Wetlands are a key practice to help accomplish this but feasible sites need to be identified in each watershed to evaluate the potential contribution of nutrient removal in wetlands for watershed planning purposes. This study's objective was to demonstrate that LiDAR topographic data can be used to locate feasible wetland sites in a 6500 ha watershed in northern Illinois, and then estimate the potential of wetlands at those locations to reduce watershed scale nitrate-N loads. The first evaluation, based on conservative siting criteria, identified eleven sites where wetlands could intercept tile drainage from 30% of the watershed. The USDA AnnAGNPS model was used to estimate nitrate loads delivered to the wetland locations and from the watershed during a 30-year simulation. Model results were consistent with discharge and nitrate load regimes in the region. Nitrate reduction by the wetlands was estimated based on published regression models. The wetlands could reduce average watershed nitrate loads by 11-16%, a significant reduction from treating less than 2% of the watershed with a single practice that would provide other ecosystem services. Alternative siting criteria were explored using the LiDAR data to identify a wetland placement scenario that could reduce nitrate-N loads by 45%, the reduction being targeted to mitigate Gulf hypoxia. Results of the simulations showed wide variation in N-removal performance among wetlands based on contributing-to-wetland area ratios, and the impacts of land use on discharge and N loads to individual wetland locations. Wetland siting criteria will need to be flexible to achieve nutrient reduction goals in watersheds. The variation in wetland N-removal performance and flexible siting criteria should be considered in planning watershed conservation efforts and establishing nutrient trading schemes.