Wetlands Reduce Nutrient Pollution and Greenhouse Gases Emissions

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Introduction

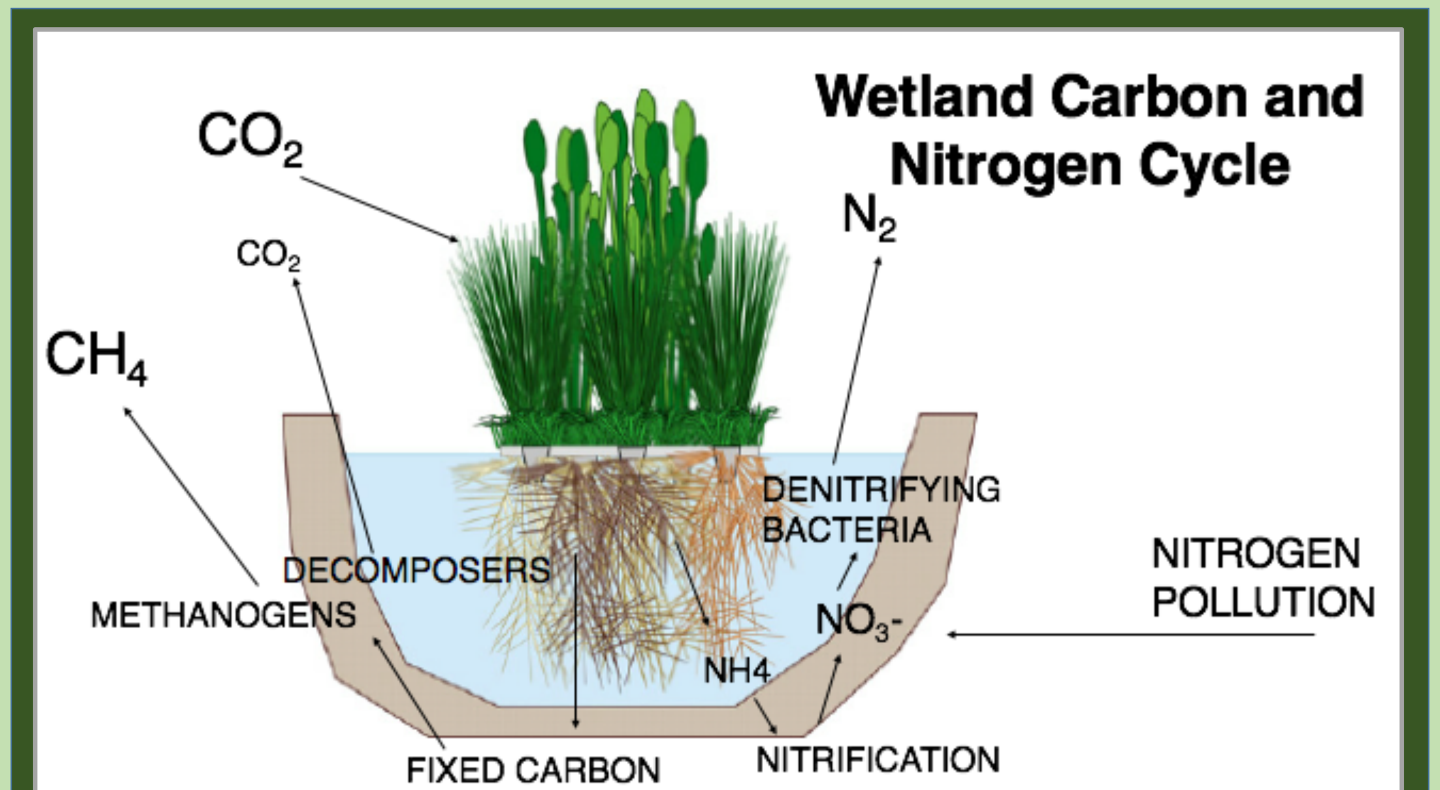

Figure 1. Scheme of a Wetland carbon and nitrogen cycles

Hydrological dynamics of wetlands can provide ecological services such as nitrogen removal due to denitrifying bacteria in anoxic soils and carbon sequestration due to slow decomposition rates

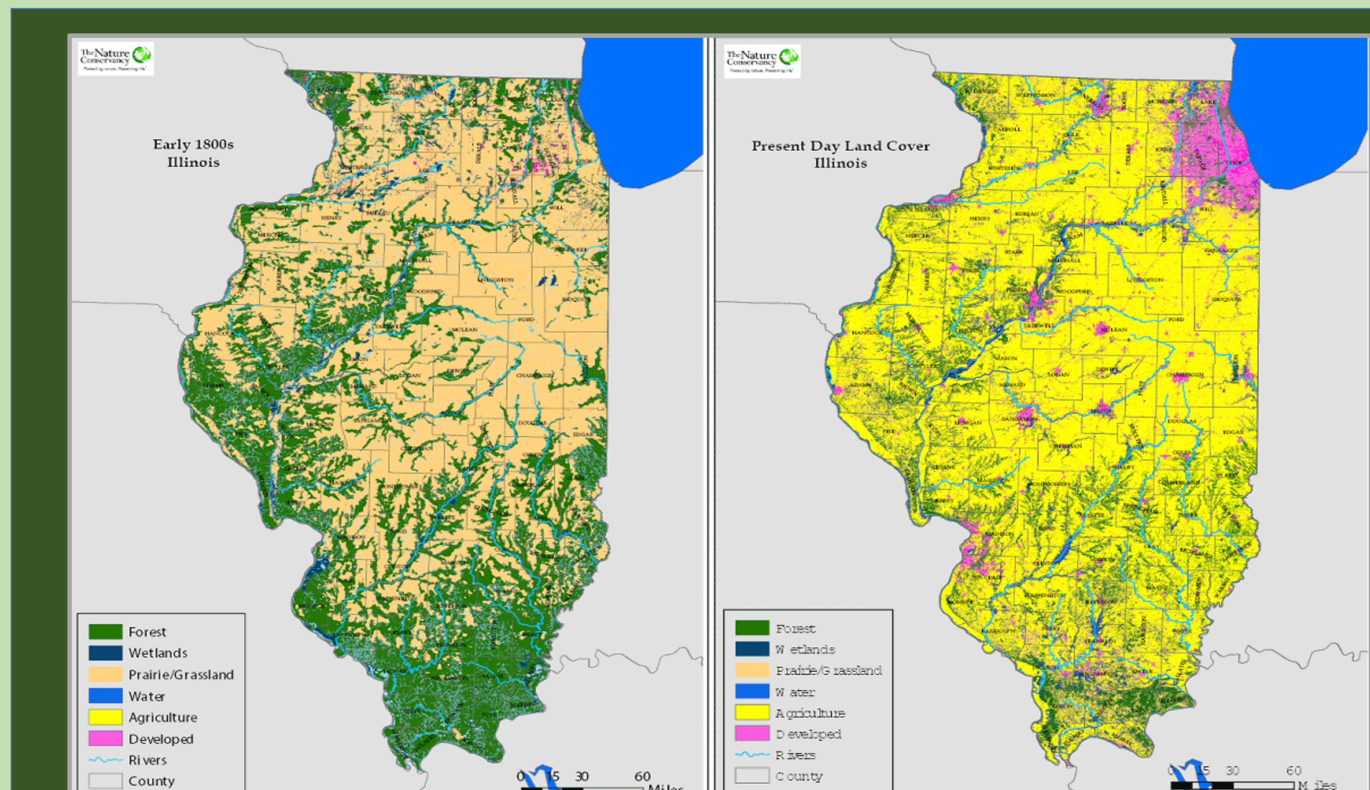

Figure 2. Land cover of the State of Illinois in the 1800s (left) and today (right).

Illinois land cover has changed from forest and prairies to agricultural land and developed cities causing more pollution to our waterways and greenhouse gas emission. Our hypothesis was that wetlands restoration would increase nutrients and carbon uptake.

Objectives

To examine the potential of wetlands to diminish nitrogen pollution and the potential of carbon sequestration by restored wetlands in order to mitigate effects of anthropogenic activity

Methods

- Use stable isotopic composition of soil and water to describe the hydrological dynamics of a 2500 acre restored wetland in Hennepin, IL
- Establish the initial C, N and P budgets for the wetland ecosystems
- Track these budgets for several years after implementation of wetland management

Figure 3. Hennepin-Hopper lake, our study site, is a wetland located along the Illinois River and was restore from agricultural land in 2001 http://isgs.illinois.edu/ilhap

Results

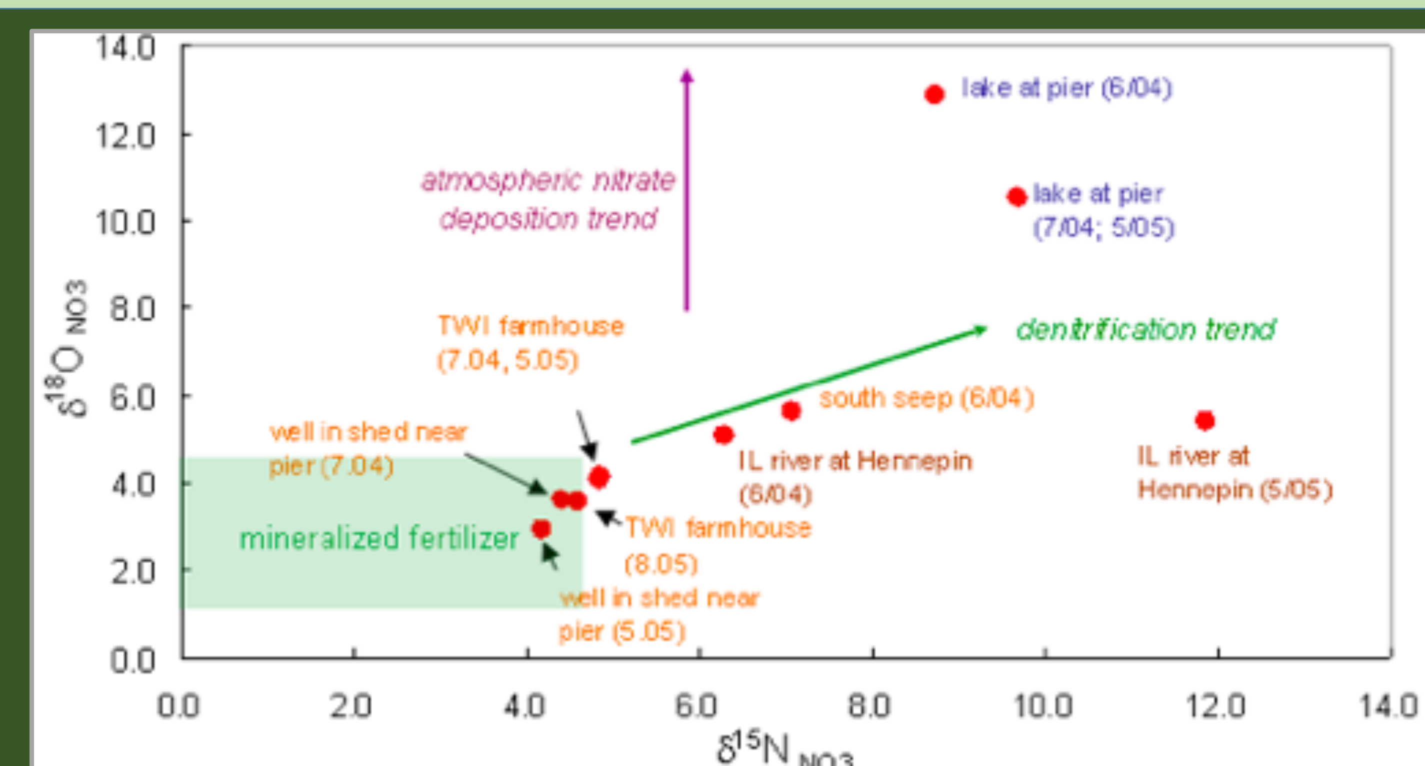

Figure 4: ^{15}N and ^{18}O concentrations of nitrate from groundwater, the Illinois River and Hennepin-Hopper Lake. Low nitrate levels and an increase in the proportion of N15 and O18 in NO3 remaining in the wetland outflow shows evidence of denitrification as a means of nitrate removal

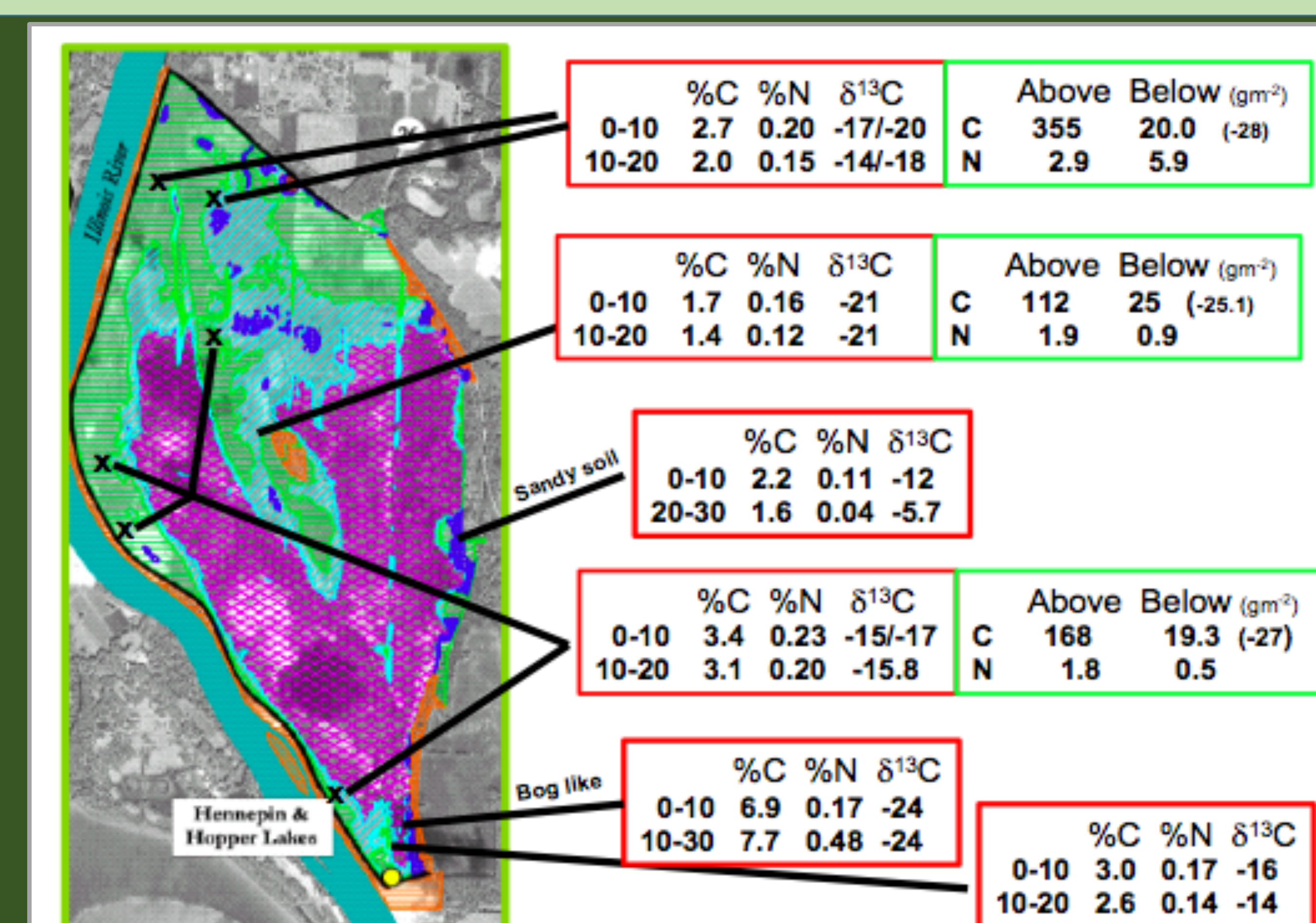

Figure 5: The biomass (aboveground and belowground), nutrient content, and soil carbon at depths of 0-10 cm and 10-20 cm (2003-2004). Increasing C and N soil concentrations indicate that atmospheric CO_2 is being quickly dissolved into the lake water as the rates of lake photosynthesis (consumption of dissolved CO_2) are sufficiently high to direct the flow of atmospheric CO_2 into the wetland system favoring carbon storage and offsetting methane emission

Nutrient Source	Land Area Needed (ha)	Sequestration Carbon-equivalents **dry wetlands C**-density 20 kg C m^{-2}(mt CO_2 year^{-1}	Sequestration Carbon-equivalents **Nutrient farming C**-density 20 kg C m^{-2}(mt CO_2 year^{-1}	2002-2004 Illinois coal-CO_2 emissions reduction from nutrient farming (%)
Chicago Metropolitan WRP	76,500	32,900	175,950	3.0
Illinois River WRPs	158,000	68,450	363,400	6.1

Table 1: Annual wetland C sequestration potential of nutrient farming over the next 30-40 years after restoration based on the number of hectares needed for removing the nutrient load by either the Chicago metropolitan water treatment plans (WTP), or all the combined WRP for the entire Illinois river Basin. Nutrient farming in Illinois over the next 30 years could reduce the total greenhouse gas emissions from coal plants in Illinois in 2002-2004 by over 6 %

Conclusions

- Nitrate composition is evidence that denitrification is the cause of NO_3 loses in the constructed wetland
- The C:N ratio of soils indicate accumulation of relatively fresh organic matter, which is indicative of slow decomposition rates and high presence of particulate organic matter – favorable for carbon sequestration
- The restoration of lost wetland area can be a cost-effective method to reduce N pollution and CO_2 emission

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