



CARBON SEQUESTRATION IN WETLANDS

A Short Summary of the Current Scientific Literature with Information Specific to Minnesota

Prepared for Rep. Jean Wagenius by Board of Water & Soil Resources staff, December 2008

CARBON SEQUESTRATION, FLUX

Wetlands sequester carbon from the atmosphere through plant photosynthesis and by acting as sediment traps for runoff. Carbon is held in the living vegetation as well as in litter, peats, organic soils, and sediments that have built up, in some instances, over thousands of years. The magnitude of storage depends upon wetland type and size, vegetation, the depth of wetland soils, groundwater and nutrient levels, pH, and other factors. One study gave the carbon storage of a prairie pothole wetland at 1.23 mT/acre/year.¹ Wetlands also release carbon both through natural, seasonal changes and, more drastically, when their equilibrium is affected by human interference.²

With wetlands holding large amounts of carbon³, the fate of existing wetlands is a factor in predicting carbon emissions. The loss of an existing wetland means not only the loss of that particular carbon sink, but also that the carbon in that wetland will be released, adding to the total carbon load in the atmosphere.

CLIMATE CHANGE EFFECTS ON WETLANDS

Scientists point to several factors that may affect wetlands given carbon-driven climate changes: increased carbon dioxide concentrations (carbon is the building block of a plant's "diet"), a longer growing season due to increased temperature, increased water to some drier wetlands, decreased water (and thus more vegetation) in deep systems. These changes can be predicted no better than forecasts of climate change. Wetlands as we know, and research, them, will change.

INCREASING CARBON STORAGE/CONTROLLING CARBON RELEASE

There are conflicting opinions on how to increase carbon sequestration in wetlands. One well-regarded scientist recommends planting coniferous, shrub, and forested wetlands and creating seasonal wetlands that do not flood for long periods.⁴ A study from the University of Minnesota suggests the opposite, that it is the continually-flooded parts of a wet marsh system that store the most carbon.⁵ Overall, research studies agree that carbon storage is enhanced in wet systems.⁶ Also, evidence suggests more carbon is sequestered by a richer mix of native species. Species-rich ecosystems are more stable over time and may provide a faster, stronger response to future changes in atmospheric carbon dioxide concentration.

Efforts are underway to be more precise about exactly what sort of carbon storage can be expected, given a certain type of wetland. A report to the Minnesota Legislature was prepared earlier this year that estimates prairie potholes restoration could sequester 1.35 million metric tons of carbon dioxide per year.⁷ That study recommends certain land use changes, including wetland restoration and protection, be included as development priorities at the local, regional, and state level. Also in our region, the University of North Dakota Energy and Environmental Research Center (EERC) is overseeing a wetland/grassland sequestration program, one of seven pilot projects sponsored by the U.S. Department of Energy.⁸

SCIENTIFIC BASIS FOR WETLAND MANAGEMENT

One paper, prepared by Jon Kusler as a project conducted by the Association of State Wetland Managers and from a literature review with funding from the U.S. EPA⁹, proposes that there is sufficient scientific basis now to change wetland management practices to protect wetlands, and their carbon stores, from climate change. Kusler points out that this is particularly true when changes serve multiple additional objectives, such as ecological benefits and flood storage.

METHANE EMISSIONS OFFSET CARBON INTAKE

Methane is a greenhouse gas produced by bacteria present in wetlands. Wetlands produce significant amounts of methane. Methane is an active compound; its “global warming potential” is rated 21, compared to one for carbon dioxide.¹⁰ Scientists debate how much the increased carbon storage of a wetland is offset by the increased methane production, although there is agreement that holding stored carbon in existing wetlands, especially peat land, is crucial. Climate, water chemistry, and soil type are three variables affecting both carbon storage and methane emission.

MINNESOTA

Minnesota has produced several responses to the growing alarm over atmospheric carbon. Minnesota is one of nine Midwest states to join Manitoba in signing the Midwest Regional Greenhouse Gas Reduction Accord.¹¹ The University of Minnesota’s Center for Integrated Natural Resources and Agricultural Management has produced a *Landowners Guide to Carbon Sequestration Credits*.

In 2006, the UM Water Resources Center’s Minnesota Terrestrial Carbon Sequestration Project conducted a series of “early input” stakeholder meetings with agricultural, forestry, government, business, and environmental-conservation groups.¹² Their summary discusses areas where there is consensus and suggests preliminary steps that could scale up state-level sequestration activities.¹³

Although wetland restoration plays a small part in reducing carbon, the large wetland potential in Minnesota suggests that wetland preservation and restoration will be an important part of meeting reduction targets.

NOTES FROM THE TEXT

¹ Polasky, Stephen, and Y. Liu. 2006. [The Supply of Terrestrial Carbon Sequestration in Minnesota](#). St. Paul: University of Minnesota.

Peatland carbon storage has been estimated at 0.2 mT/acre/year, with the caveat that peat absorbs continuously over thousands of years, whereas most systems (other wetland, prairie grasslands (0.41 mT/acre/year, forest (0.48 mT/acre/year)) peak at 50-100 years.

Carbon storage can be measured in many ways; one common standard is metric tons per acre per year, which is abbreviated as mT/acre/year. Reported numbers, however, are subject to error; Carl Trettin, a researcher with the U.S. Forest Service, reported at a recent conference [Wetlands and Global Climate Change, September 2008, Portland, OR] that soil carbon varies depending on very slight differences in how the soil sample is taken and processed. Small errors add up, multiplying to make “a huge difference in the final calculation,” according to Trettin. Another reference is from: Burras, Lee. [Field Scale Variability in Soil Carbon, Quality & Morphology – Experiences from Iowa](#). (St. Paul: UMN Terrestrial Carbon Sequestration Forum, March 9, 2006).

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- ² Kusler, Jon. *Acclimations*. Newsletter of the US national assessment of the potential consequences of climate variability and change. July-August, 1999.
- ³ Wetlands hold between 14-35% of the total terrestrial carbon, (Kusler, *Acclimations*, and *Prairie wetlands and carbon sequestration: assessing sinks under the Kyoto Protocol*. David Wylynko, Editor. International Institute for Sustainable Development (IISD), Manitoba, Canada. September 1999.)
- ⁴ Adamus, Paul. *Mitigating Global Climate Change: Which Kinds of Wetlands Help, Hurt, or Have Minimal Effect?* Presented at the Association of State Wetland Managers Annual Conference, September 2008.
- ⁵ Lennon, M. Water Resources Science graduate student. Personal correspondence.
- ⁶ Lennon, Megan and E.A. Nater. 2006. [Biophysical Aspects of Terrestrial Carbon Sequestration in Minnesota](#). St. Paul: University of Minnesota.
- ⁷ *Report to Minnesota Legislature on Carbon Sequestration Capacities in Minnesota*. Jim Anderson et al. 2008. [The Potential for Terrestrial Carbon Sequestration in Minnesota. A Report to the Department of Natural Resources from the Minnesota Terrestrial Carbon Sequestration Initiative](#). St. Paul: University of Minnesota.
- ⁸ Miller, Cheryl and D. Current. 2006. [Terrestrial Carbon Sequestration: A Survey of Policies and Programs](#). St. Paul: University of Minnesota.
- ⁹ Kusler, Jon. *Common questions: wetland, climate change, and carbon sequestering*. Association of State Wetland Managers, Inc. aswm.org/propub/11_carbon_6_26_06.pdf .
- ¹⁰ Global Warming Potential values from the 1996 IPCC Second Assessment Report, summarized in *Global Mitigation of Non-CO₂ Greenhouse Gases* (EPA Report 430-R-06-005). epa.gov/climatechange/economics/downloads/GM_SectionI_TechnicalSummary.pdf
- ¹¹ <http://www.midwesterngovernors.org/govenergynov.htm>
- ¹² Miller, Cheryl and D. Current. 2006. [Terrestrial Carbon Sequestration: A Survey of Policies and Programs](#). St. Paul: University of Minnesota.
- ¹³ Donnelly, Aldyen. [Minnesota: a Great Place to Start a Global Carbon Market](#). (St. Paul: UMN Terrestrial Carbon Sequestration Forum, November 14, 2005).