CO_2 Sequestration Through Habitat Restoration – Defining Best Terrestrial Sequestration Practices for Landowners

Terrestrial Carbon Sequestration

Increasing levels of greenhouse gases (GHGs), including carbon dioxide (CO_2), in the atmosphere are raising concerns over the effects on climate and weather. Humans are currently adding more than 25 billion tons of CO_2 to the atmosphere each year.[1-3] Most of this CO_2 comes from anthropogenic sources (fossil fuels), but deforestation and common agricultural tillage practices are also contributing. The U.S. Department of Agriculture estimates that 150 to 220 billion tons of CO_2 have been released from soils in the U.S. portion of North America since the early 1800s.[4] The process of removing CO_2 from the air and storing the carbon back into the soil is what terrestrial carbon sequestration is all about (see What Is Terrestrial Carbon Sequestration?).

Practices that support terrestrial carbon sequestration include habitat restoration, reforestation, and no-till farming. Terrestrial sequestration is emerging as a viable business opportunity for landowners (see Carbon as a Crop) and offers an immediate response to the threat of global climate change.

Best Practices for Terrestrial Sequestration

As part of the Plains CO_2 Reduction (PCOR) Partnership Phase II Program, **Ducks Unlimited Inc. (DU)**, the **U.S. Geological Survey's Northern Prairie Wildlife Research Center**, and **North Dakota State University** will be demonstrating optimal practices for sequestering CO_2 through the restoration of Prairie Pothole Region (PPR) wetlands and surrounding grasslands at a site in north-central South Dakota. The project results are intended to serve as a model to promote and implement terrestrial sequestration across the PPR (Figure 1).[5]

Sequestration Through Habitat Restoration

A major portion of the PCOR Partnership team effort is focused around a multiyear wetland/grassland complex restoration project (fall of 2006 to fall of 2009) located in north central South Dakota. The project will implement land management practices that will restore wetland and grassland areas to presettlement characteristics and foster the replacement of the soil carbon lost during tillage since European settlement. The PCOR Partnership team will measure and determine the rate of carbon sequestration in different portions of the project site landscape. The project team will also monitor erosion, runoff, habitat quality, and the need for chemical inputs, as well as develop materials and capabilities to help landowners undertake successful carbon sequestration activities.

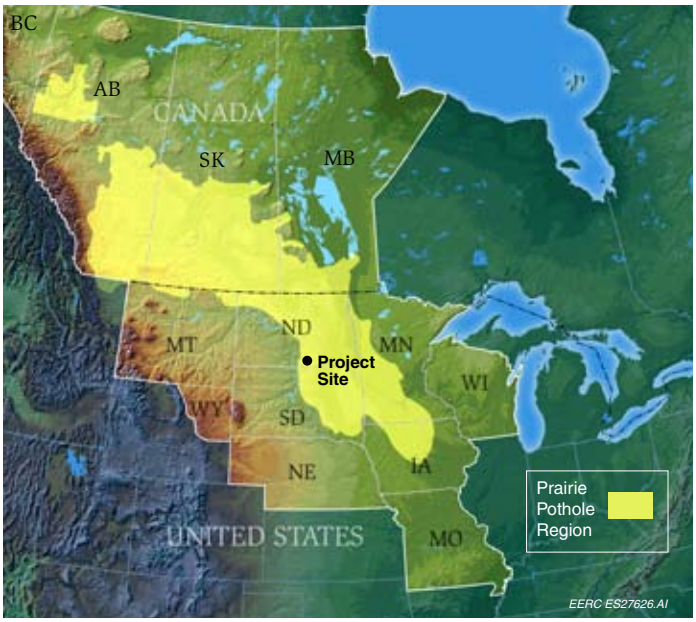

Figure 1. The PCOR Partnership region showing the extent of the PPR wetlands and the location of the PCOR Partnership Terrestrial Carbon Sequestration Field Validation Project.

What Is Terrestrial Carbon Sequestration?

Plants take in CO_2 (carbon dioxide: a gas composed of one atom of carbon or "C" and two atoms of oxygen or "O") from the atmosphere through their leaves. Plants use the carbon [the C in the CO_2] to make roots, stems, sap, seeds, and leaves. Plants exhale the oxygen [O_2] back to the atmosphere. When the plant winters or dies, part of the carbon from the plant is preserved (sequestered) in the soil in the form of roots or plant debris. If the soil is disturbed, the sequestered carbon can come into contact with oxygen in the air. If this happens, some of the exposed soil carbon will combine with O_2 and reenter the atmosphere as CO_2. This decreases the amount of carbon sequestered in the soil. For this reason, careful land management is critical to successful terrestrial sequestration.

Figure 2. Recent work by the PCOR Partnership team indicates that landscape restoration in the extensive PPR of the northern Great Plains represents a major opportunity for terrestrial carbon sequestration.

Learning How Carbon Is Sequestered in Wetlands

Recent work indicates that restored wetlands are very efficient at carbon sequestration and build up soil carbon at a rate of 1.1 tons per acre per year.[5] The PCOR Partnership team will determine soil carbon buildup (carbon sequestration) rates in wetlands and the budget of the GHGs, including carbon-based gases (CO_2 and methane) as well as nitrous oxide (N_2O), in both the wetlands and adjacent grasslands following habitat restoration.

Learning How Carbon Is Sequestered in Grasslands

The PCOR Partnership team is quantifying the amount of carbon sequestered in restored grasslands. This will help develop reliable estimates of carbon sequestered under various grassland management methods and will determine the soil organic carbon levels one can expect from grasslands under common land management practices (i.e., pasture, haying).

Developing Terrestrial Carbon Sequestration "Best Practices"

Carbon sequestration is a winning opportunity for all. Landowners have the opportunity to generate income by changing land-use practices. Industry receives carbon offsets for meeting an environmental challenge, and the general public gets cleaner air and water, flood protection, and more wildlife habitat. Most importantly, DU fulfills its mission of conserving waterfowl habitat and wetlands conservation using a new funding stream that nobody imagined 10 years ago.[6] Through this project, the PCOR Partnership team will test and refine best management practices for different portions of the landscape that will help landowners maximize carbon sequestration and minimize the emission of other GHGs like methane and N_2O in prairie grasslands and prairie pothole wetlands.

Terrestrial Sequestration Tools for Landowners

The terrestrial sequestration best practices developed during this project will be communicated to landowners through workshops, fact sheets, and Web-based geographic information system products. The centerpiece of this business support package is a Web-based computer model designed to aid landowners in optimizing land management techniques for different portions of the landscape to ensure that they can maximize their land's ability to sequester carbon.

Carbon as a Crop — Terrestrial Sequestration and Carbon Offsets

By sequestering carbon in the ground, emissions of GHGs like CO_2 can be "offset" or negated. These types of offsets offer an effective alternative to refitting existing technology or building new facilities. For this reason, sequestering carbon in the landscape could become a significant source of revenue for landowners in the future. In the United States, for example, the Chicago Climate Exchange is certifying and trading credits based on the buildup of soil carbon in agricultural lands, and groups like DU are developing an approach to credits that will reflect benefits to species, water resources, and soil carbon buildup. At the international level, protocols are being refined so that credits from terrestrial projects can be readily certified and traded under the Kyoto Protocol framework.

References and Notes

1. www.eia.doe.gov/oiaf/1605/ggccebro/chapter1.html (accessed November 2004) **2.** GtC = gigatons of carbon; 1 gigaton equals 1 billion or 1,000,000,000 metric tons (a metric ton is 1000 kilograms); 1 metric ton = 2204.6 pounds or 1.1 English system tons (an English system ton is 2000 pounds). **3.** Based on the ratio of the weights of the atoms of carbon and oxygen, 1 ton of carbon would combine with 2.667 tons of oxygen to form 3.667 tons of CO_2. **4.** U.S. Department of Agriculture, 2004, Agriculture and forestry greenhouse gas inventory: 1990–2001. Global Change Program Office, Office of the Chief Economist, Technical Bulletin No. 1907, p. 163. **5.** Gleason, R.A., Euliss, N.H., Jr., McDougal, R., Kermes, K.E., Steadman, E.N., and Harju, J.A., 2005, Potential of restored prairie wetlands in the glaciated North American Prairie to sequester atmospheric carbon: Plains CO_2 Reduction (PCOR) Partnership Topical Report for the U.S. Department of Energy and multiclients, Grand Forks, North Dakota, Energy & Environmental Research Center, July 2005. **6.** Kempka, D., 2006, DU's carbon program benefits ducks: Ducks Unlimited, March/April, p. 22–23.

The Plains CO_2 Reduction (PCOR) Partnership is a group of public and private sector stakeholders working together to better understand the technical and economic feasibility of sequestering CO_2 emissions from stationary sources in the central interior of North America. The PCOR Partnership is managed by the Energy & Environmental Research Center (EERC) at the University of North Dakota and is one of seven regional partnerships under the U.S. Department of Energy's National Energy Technology Laboratory Regional Carbon Sequestration Partnership Initiative. To learn more, contact:

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Visit the PCOR Partnership Web site at www.undeerc.org/PCOR. New members are welcome.

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