EERC

PCOR Partnership

Plains CO_2 Reduction (PCOR) Partnership

Fact Sheet

Practical, Environmentally Sound CO_2 Sequestration

Terrestrial Carbon Sequestration Validation Test

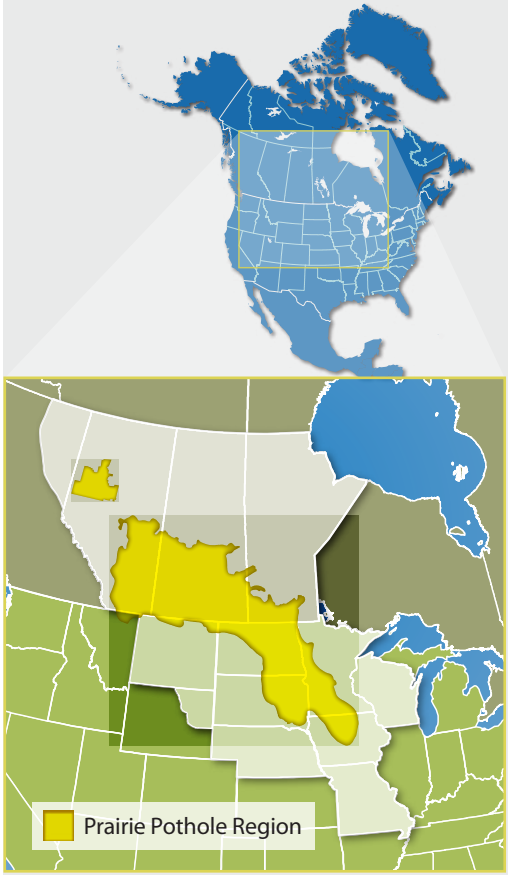
The Plains CO_2 Reduction (PCOR) Partnership brought together key research groups in the United States and Canada to 1) identify, develop, and apply alternative land use management practices to the Prairie Pothole Region (PPR) that result in the reduction of greenhouse gases (GHGs) and 2) develop the business framework necessary for the verification and monetizing of carbon offsets, also called carbon credits. The project was one of four field validation tests under the PCOR Partnership's Phase II program (fall 2005 to fall 2009).

Goal and Key Results

The project was designed to 1) evaluate land management practices that increase soil carbon storage while reducing GHG emissions; 2) improve and refine current monitoring, assessment, and verification methodologies; 3) model land use changes and economic impacts for areas undergoing restoration; and 4) develop protocols necessary to monetize carbon storage for the sale of terrestrial carbon credits. Results included the following:

- Demonstration that converting cropped upland areas to hayland and restoring prairie wetlands/upland grassland complexes increase soil carbon.
- Demonstration that soil carbon uptake associated with restoring wetland catchments exceeded GHG emissions in both wetland and adjacent grassland tests.
- Practical, decision-making tools for landowners based on customized site-specific soil carbon models that can estimate cost–benefit ratio of land conversion for sequestration.
- A practical science-based protocol for verifying and monetizing grassland carbon credits.

Fast Facts



Location: U.S. portion of the PPR

Settings: wetland/upland complexes in grasslands, native prairie, and cropland

Monitoring: 4 years

Partners: Ducks Unlimited, Inc. (DU); Ducks Unlimited Canada (DUC); U.S. Geological Survey (USGS); North Dakota State University (NDSU); U.S. Department of Energy; and PCOR Partnership, led by the Energy & Environmental Research Center (EERC)

This project was the first to be certified by the Climate, Community, and Biodiversity Standards in the United States and is the first Avoided Grassland Conversion project in the world.

Test Approach

Field research performed by USGS and DUC (figure at right: Studies 1 and 2) provided the context for the activities of the PCOR Partnership terrestrial validation test field activities (figure at right: Studies 3, 4, and 5). Studies 1 and 2 provided the foundation for estimating carbon accumulation rates in grasslands and wetlands and served as a preliminary assessment of terrestrial sequestration potential in prairie soils[1] which helped focus research efforts for these validation tests. Grassland and wetland sample locations for all test sites in the U.S. portion of the PPR were selected based on proximity to existing monitoring and research stations.

Soil Carbon in Restored Grasslands

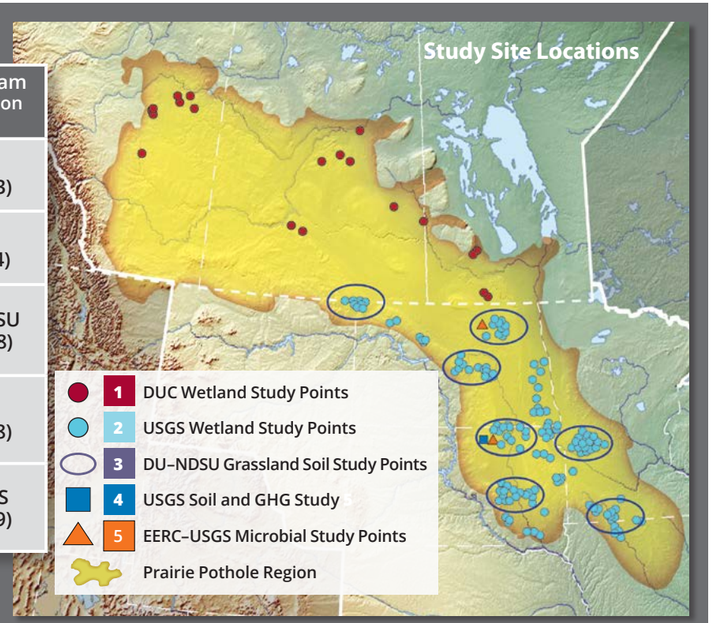
DU and NDSU collected soil samples on 14,250 acres in Montana, North and South Dakota, Minnesota, and Iowa during the 2006 to 2008 growing seasons (figure at right: Study 3). Field sites represented previously farmed land enrolled in conservation programs that were reseeded to tame or native grasses. Grasslands of varying ages were analyzed to determine the rate of carbon uptake and retention compared to cropland and undisturbed grassland. Results indicated that although carbon sequestration rates were highly variable throughout the region, carbon uptake and retention showed strong correlations with annual temperature, precipitation and land management activities. ***This suggested that under proper management, restored grasslands in the PPR could be managed to improve carbon uptake and retention in soil.***

Soil-profile cores were extracted during the course of the study to measure changes in soil carbon at different depths.

Prairie Pothole Region Field Studies

Study No.	Research Activities Contributing to the Terrestrial Validation Field Test	Research Team (data collection period)
1	Pretest carbon flux assessments in 21 field areas across 3 Canadian provinces	DUC (2002–2003)
2	Pretest carbon flux assessments at approximately 570 field sites in 7 field areas across 5 states	USGS (1997/2004)
3	Test: soil carbon levels of 2850 samples representing 14,250 acres of previously cropped grassland in 7 field areas across 5 states	DU and NDSU (2006–2008)
4	Test: carbon flux assessments at 17 wetland catchments representing 3 land use types in Edmunds County, SD	USGS (2007–2008)
5	Test: laboratory (soils from Cando, ND) and in situ study (Ipswich, SD) experiments investigating the effect of microbial activity on GHG emissions	EERC/USGS (2007–2009)

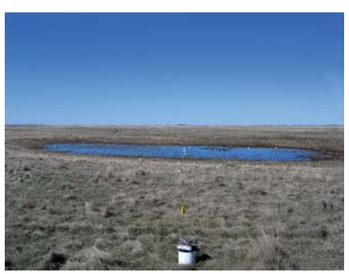
The results of these scientific studies provided the necessary data to define best practices for carbon sequestration potential in the northern Great Plains.

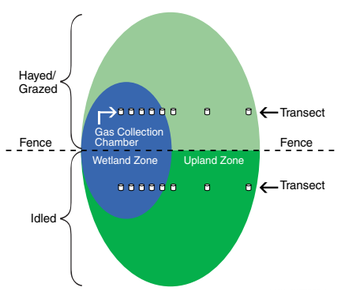


Soil GHG Budget and Land Management

During the 2007 and 2008 growing seasons, USGS evaluated GHG emissions and soil carbon accumulation of three land management practices involving wetland catchments in Edmunds County, South Dakota (figure above: Study 4). Researchers monitored GHG emissions (N_2O, CH_4, CO_2) from 17 restored wetland sites under different land uses: 1) cropland, 2) restored grassland (idle, hayed), and 3) native prairie (idle, grazed). ***Results suggested that changing land use from cropland to grazing and/or haying would provide significant carbon uptake and retention in that portion of the PPR.[2] In addition, emissions of GHGs in restored wetlands would not exceed potential soil carbon storage benefits associated with restored wetland catchments.***

Gas exchange was sampled biweekly (right) from static chambers transecting uplands and wetlands under different land uses (bottom).





Soil Microbes and Carbon Budget

The EERC and USGS performed laboratory and in situ studies (Cando, ND, soils and Ipswich, SD, field site, respectively) to evaluate the effects of microbial cycling of CO_2, CH_4, and N_2O in restored wetlands (figure above: Study 5). The studies 1) characterized the cycling effects of CO_2, N_2O, and CH_4 in wetlands "before" and "after" restoration; 2) evaluated the potential of restoration to sequester CO_2; 3) examined the effects of land management changes on CH_4 and N_2O emissions with and without the addition of N-fertilizer; and 4) assessed wetland restoration on soil microbial community structure and population dynamics, especially those populations involved in the production and consumption of CH_4 and N_2O. ***Results of both studies demonstrate that restoring farmed wetlands (including cutting off fertilizer inputs) would result in 1) reduction of CO_2 flux and increased soil carbon storage and 2) reduction of CH_4 and N_2O emissions.[3]***

Soil Column Design

In Situ Study

DU's Carbon Credit Program

Creating a Model Monetization Procedure

DU used scientific research results from the PCOR Partnership project to develop a robust methodology of land management strategies and verification protocols to create soil-based carbon credits (similar to a stock certificate) from grasslands in the northern Great Plains.

These definition and verification protocols for soil carbon content were accepted by the Climate, Community and Biodiversity Alliance (CCBA) under the 2010 edition of the CCBA verification standards.

Creating a Model Buyer/Seller Framework

DU worked with landowners to obtain perpetual grassland easements associated with the carbon credit instrument, essentially transferring the carbon storage value of the property to the carbon credit (and thus to its buyer).

In May 2008, DU launched a system to track carbon transaction information, including land unit information, carbon credit serial number, value (tons of carbon stored), and business requirements for inventorying and tracking offsets. The system also estimated the carbon value of various land management strategies for specific units of land as an aid to landowners looking to develop carbon credits on their property.

Selling Credits into the Marketplace

In September 2008, approximately 130,000 tons of native grassland soil-based carbon credits were sold to American International Group, Inc., which then sold the credits through the Chicago Climate Exchange, a voluntary carbon market in the United States.

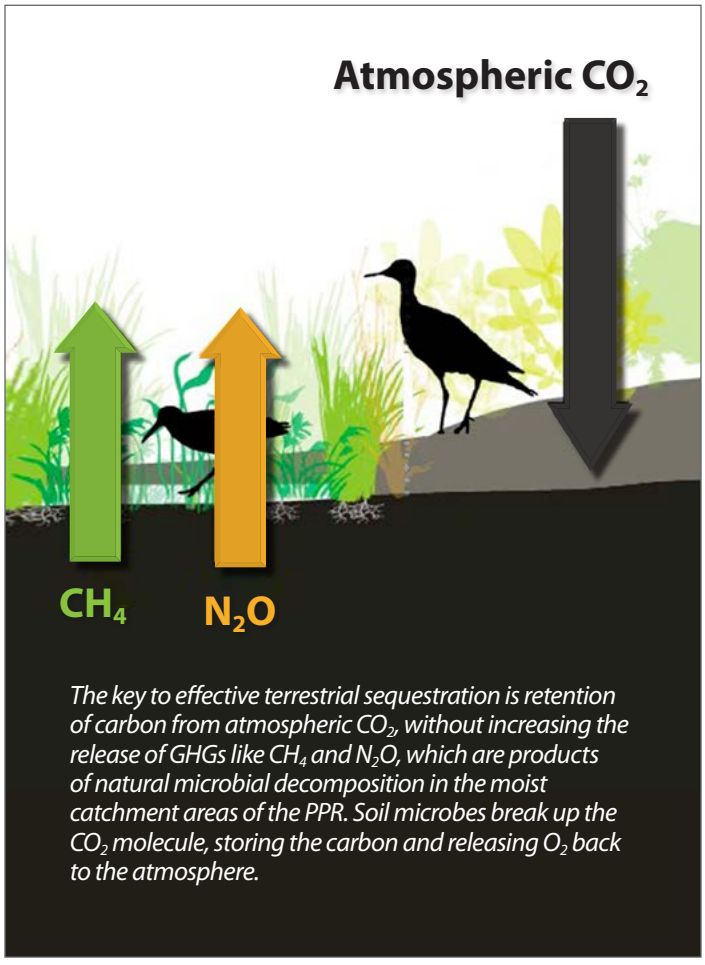
First to Achieve "Gold Level" Rating

Carbon credit buyers need to know that the tons of carbon they are paying for is stored in the soil. Carbon credit contractors like DU's Carbon Credit Program require landowners to implement science-based practices and submit to periodic testing and verification. The soil-carbon grassland protocols were awarded a Gold Level rating under the CCBA standards in March 2009. DU's protocols were the first in the world to meet the rigorous qualifications for scientific underpinning, transaction support, and stakeholder engagement set by CCBA. Learn more at **www.climate-standards.org.**

Terrestrial Basics

What Is Terrestrial Carbon Sequestration?

Terrestrial sequestration uses the natural absorption of atmospheric CO_2 by plants (photosynthesis) to promote long-term storage of carbon. In the grassland-dominated prairie ecosystem, carbon builds up in undisturbed soils. When the soil is plowed, soil microbes combine the carbon in the soil with oxygen from the air to form CO_2 that is then returned to the atmosphere. If soil is cropped with minimal disturbance (no-till) or if cropped land is taken out of production (e.g., seeded for grazing grasses), carbon can again begin to accumulate (that is, be sequestered). The amount of carbon that can be stored in soils has a limit. The soils will accumulate carbon until the amount of carbon added each year is equal to the amount lost to the atmosphere through microbial activity. This "steady state" is usually achieved in a few decades.



The key to effective terrestrial sequestration is retention of carbon from atmospheric CO_2, without increasing the release of GHGs like CH_4 and N_2O, which are products of natural microbial decomposition in the moist catchment areas of the PPR. Soil microbes break up the CO_2 molecule, storing the carbon and releasing O_2 back to the atmosphere.

What Is a Wetland/Upland Complex or Catchment?

Wetland is a broad term that encompasses all water occurring on the landscape, from a temporary pond to a permanent lake. Wetlands and the surrounding landscape (upland) areas that drain to the wetlands are referred to as a catchment or watershed. Wetlands can be surrounded by a variety of upland types, including grasslands, croplands, native or restored prairie, or even urban ecosystems. The PPR contains millions of relatively small catchments (from under a square mile up to a few square miles).

What Is a Carbon Offset?

A carbon offset is an action taken either to reduce the amount of carbon dioxide released into the atmosphere or to remove carbon dioxide from the atmosphere. The volume of CO_2 not emitted or removed from the atmosphere is intended to make up for or "offset" the volume of CO_2 emitted by human activities elsewhere.

What Is the Difference Between a Voluntary and Regulated Market for GHG Emissions?

In a voluntary GHG market, an entity (company, individual, or other "emitter") volunteers to offset its emissions by purchasing credits. Credits certify that a given volume of CO_2 or GHGs will not be emitted to the atmosphere. In a regulated or mandatory market, CO_2 emitters are required by law to meet specific goals (reduction targets) in a prescribed period of time.

References

[1] Gleason, R.A., and Tangen, B.A., 2009, Effects of wetland restoration on greenhouse gas flux in the Prairie Pothole Region: Unpublished manuscript.

[2] Steadman, E.N., Daly, D.J., de Silva, L.L., Harju, J.A., Jensen, M.D., Peck, W.D., Smith, S.A., and Sorensen, J.A., 2006, Geologic sequestration potential of the PCOR Partnership region: Plains CO_2 Reduction (PCOR) Partnership (Phase I) Final Report/July–September 2005 Quarterly Report for U.S. Department of Energy, Grand Forks, North Dakota, Energy & Environmental Research Center, January.

[3] Ye, D., Kurz, B.A., and Kurz, M.D., 2009, Subtask 1.22—microbial cycling of CH_4, CO_2, and N_2O in a wetlands environment: Final report (March 1, 2006 – December 31, 2008) for U.S. Department of Energy National Energy Technology Laboratory Cooperative Agreement No. DE-FC26-98FT40320, EERC Publication 2009-EERC-02-08, Grand Forks, North Dakota, Energy & Environmental Research Center.

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 storing CO_2 emissions from stationary sources in the central interior of North America. The PCOR Partnership is led 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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