



United States Department of Agriculture
Natural Resources Conservation Service

Helping People Help the Land

CEAP-Wetlands Background

November 2008

CEAP — Building the Science Base for Conservation

Science-based conservation is the key to managing agricultural landscapes for environmental quality.

The Conservation Effects Assessment Project (CEAP) is a multi-agency effort to quantify the environmental benefits of conservation practices and develop the science base for managing the agricultural landscape for environmental quality. Project findings will guide USDA conservation policy and program development and help farmers and ranchers make informed conservation choices.

The three principal components of CEAP—the national assessment, the watershed assessment studies, and the bibliographies and literature reviews—contribute to the building and evolution of the science base for conservation.

Wetlands

The goal of CEAP-Wetlands is to develop a broad collaborative foundation that facilitates the production and delivery of scientific data, results, and information. Findings will routinely inform conservation decisions affecting wetland ecosystems and the services they provide, particularly focusing on the effects and effectiveness of USDA conservation practices and Farm Bill conservation programs on ecosystem services provided by wetlands in agricultural

CEAP-Wetlands Coordinator:

Diane Eckles
diane.eckles@wdc.usda.gov
(301) 504-2312

CEAP Website:

www.nrcs.usda.gov/technical/NRI/ceap

Conservation Effects Assessment Project Prairie Pothole Regional Studies

Ecosystem Services Derived From Wetland Conservation Practices in

The U.S. Geological Survey (USGS) conducted a comprehensive, stratified survey of 204 wetland catchments in 1997 and 270 catchments in 2004, a subset of more than 2 million hectares of wetland and grassland systems established on Conservation Reserve Program (CRP) and Wetlands Reserve Program (WRP) lands. The purpose of the survey was to gather data for estimating a variety of ecosystem services provided by prairie pothole wetland catchments. In early 2008, USGS published a preliminary findings report as a result of these studies. The report is available at <http://www.usgs.gov/pp/1745/>.

Principal findings:

- Restoration practices improved the quality and species richness of the native plant community, but not to the point of full site potential.
- Catchments with a history of cultivation had less soil organic carbon in the upper soil profile than did native prairie catchments.
- Wetlands on program lands have significant potential to intercept and store precipitation that otherwise might contribute to downstream flooding; conservatively estimated, wetland catchments on program lands could capture and store an average of 1.1 acre-feet of water per acre of wetland.
- Conversion of cultivated cropland to herbaceous perennial cover through CRP and WRP enrollments reduced total soil loss from uplands by an average of almost 2 million tons per year, resulting in the delivery of less sediment and associated nutrients to sensitive offsite ecosystems such as lakes, streams, and rivers.
- Restored catchments provide at least some necessary resources for a di-

versity of bird species that cropland catchments do not; CRP and WRP enrollments led to increases in the number of grassland areas that exceeded published nesting area requirements for the five area-sensitive grassland bird species evaluated in the study.

Characterization of Prairie Pothole Catchment Soils: Implications for Delivery of Ecosystem Service

Soils data collected from 270 wetland catchments in the Prairie Pothole Region are being analyzed to evaluate changes in physical and chemical properties of soils from the shoulder landscape position down through the wetland center along a representative slope. Changes in soil properties along the toposequence will be compared among restored, agricultural (cropped), and native (untilled) wetland catchments. The overall goal of this analysis is to relate changes in soil characteristics to wetland processes and delivery of ecosystem services.

Phosphorous Speciation as an Indicator of Land Use and Conservation Practices on Wetland Condition

Most assessments of restored systems have focused on ecosystem structure (e.g., soil condition, water quality, flora, and fauna) rather than function (e.g., nutrient cycling). Consequently, functional restoration is often implied from ecosystem structure, and the link between ecosystem structure and function is rarely tested. This study proposes to evaluate the applicability of phosphorus (P) transformation as a time-integrated index of ecosystem function in restored prairie wetlands.

Land use affects vegetation cover, primary production, nutrient cycling, and microbial processes, all of which influence dynamics of soil P. Developments

in ^{31}P Nuclear Magnetic Resonance (NMR) spectrometry has provided new opportunities to “visualize” the diverse chemical forms of soil P (Newman and Tate 1980, Cade-Menun 2005) that can be linked to soil processes. NMR has been used to investigate phosphorus forms in forests, temperate pastures, steppes, marine and lacustrine sediments, estuaries, and oceans as well as managed agro-ecosystems (Clark et al. 1998, Cade-Menun et al. 2000, Carman et al. 2000, Mahieu et al. 2000, Amelung et al. 2001, Sundareshwar et al. 2001, Turner et al. 2003, Cade-Menun 2005). NMR has also advanced our understanding of mechanistic processes including fractionation of P by soil mineralogy and texture, as well as the relation of soil P speciation to soil microbial activity and diversity (Cade-Menun 2005).

The rationale for the application of P-speciation to restored prairie wetlands stems from previous work relating land use change and P-dynamics in the Carolina Bays. Diversity in chemical speciation of soil P (e.g., inorganic orthophosphate, phosphomonoesters, phosphodiesteres, and pyrophosphate) was compared along a gradient of cultivated, restored, and undisturbed reference forested-wetlands on the North Carolina Coastal Plain. Conversion of natural wetlands to agricultural production resulted in the loss of natural diversity in the chemical forms of P—analogueous to the loss of biodiversity in impacted ecosystems. Restoration of croplands to forested wetlands resulted in re-establishment of the diversity in chemical speciation of nutrients.

Importantly, chemical diversity in P forms increased with age of restoration, eventually approximating the profiles from native forested wetlands. The timeline in restoration of the chemical species of P is remarkably similar to other indices, such as the soil perturbation index (Maul et al. 1999) used to evaluate the progressive development of ecosystem biogeochemical function. These preliminary data suggest that restoration to reference conditions of wetlands previously under agriculture will likely require more than 10 years. Although other factors must be considered, these data do suggest P-speciation as a valid tool to track the progress of wetland

restoration efforts. Since chemical speciation of P is a function of biogeochemical processes, re-establishment of chemical forms of P that mirror forms observed in reference ecosystems strongly suggests a restoration of biogeochemical function.

These studies clearly show that P-speciation can be used to link ecosystem structure and function, and to track biogeochemical function of restored ecosystems. As part of this study, researchers will conduct studies to address the following objectives to gain a better understanding of P dynamics as an assessment tool of restored prairie wetlands:

- Examine spatial variation in P-diversity along a toposequence within wetland catchments.
- Evaluate how P-diversity in wetland catchments varies with hydrologic function.
- Examine the relationship between soil P-diversity and aboveground plant diversity.
- Evaluate P-diversity in restored, cropland, and native wetlands in North Dakota, Minnesota, and Iowa.

Determination of Wetland-Groundwater Relations Using Soil Characteristics

During 2004, researchers from USGS conducted surveys of 270 sites across the Prairie Pothole Region to evaluate ecosystem services provided by wetland catchments restored through U.S. Department of Agriculture (USDA) conservation programs. Analyses suggested that variation in factors such as climate, hydrology, and soil often obscured the anticipated effects of current and historical land-use practices on ecosystem services such as carbon sequestration.

The goal of this study is to reduce some of the variation in the 2004 data by re-classifying sites based on their long-term hydrology (i.e., groundwater discharge/recharge). The research intends to accomplish this by using ordination techniques to identify sites that are similar to each based on soil characteristics that indicate ground water connection (e.g., specific conductance, inorganic carbon, effervescence, presence of carbonate horizons, etc.).

If this data-driven reclassification of sites proves to be viable, it would allow for reanalysis of ecosystem services, such as carbon sequestration, that were likely affected by comparing sites that differed with respect to hydrology. Additionally, this reclassification would allow us to explore relations among wetland hydrology and remotely sensed data such as the National Wetlands Inventory and Soil Survey Geographic database. If relations between wetland hydrology and remotely sensed data are identified, this could facilitate accurate, large-scale spatial estimations of ecosystem services provided by USDA programs.

References

- Amelung, W., A. Rodionov, I.S. Urusevskaja, L. Haumaier, and W. Zech. 2001. Forms of organic phosphorus in zonal steppe soils of Russia assessed by ^{31}P NMR. *Geoderma* 103:335-350.
- Cade-Menun, B.J. 2005. Characterizing phosphorus in environmental and agricultural samples by ^{31}P nuclear resonance spectroscopy. *Talanta* 66:359-371.
- Cade-Menun, B.J., S.M. Berch, C.M. Preston, and L.M. Lavkulich. 2000. Phosphorus forms and related soil chemistry of Podzolic soils on northern Vancouver Island. I. A comparison of two forest types. *Canadian Journal of Forest Research* 30:1714-1725.
- Carman, R., G. Edlund, and C. Damberg. 2000. Distribution of organic and inorganic phosphorus compounds in marine and lacustrine sediments: A ^{31}P NMR study. *Chemical Geology* 163:101-114.
- Clark, L.L., Ingall, E.D., and R. Benner. 1998. Marine phosphorus is selectively remineralized. *Nature* 393:426.
- Mahieu, N., D.C. Olk, and E.W. Randall. 2000. Analysis of phosphorus in two humic acid fractions of intensively cropped lowland rice soils by ^{31}P -NMR. *European Journal of Soil Science* 51:391-402.
- Maul, R.S., M.M. Holland, A.T. Mikell, and C.M. Cooper. 1999. Resilience of forested wetlands located in the southeastern United States: Demonstration of a soil perturbation index. *Wetlands* 19:288-297.

- Newman, R.H., and K.R. Tate. 1980. Soil phosphorus characterization by ³¹P-nuclear magnetic resonance. *Communications in Soil Science and Plant Analysis* 11:835-842.
- Sundareshwar, P.V., J.T. Morris, P.J. Pellechia, H.J. Cohen, D.E. Porter, and B.C. Jones. 2001. Occurrence and ecological significance of pyrophosphate in estuaries. *Limnology and Oceanography* 46:1570-1577.
- Turner, B.L., N. Mahieu, L.N. Condon. 2003. The phosphorus composition of temperate pasture soils determined by NaOH-EDTA extraction and solution ³¹P NMR spectroscopy. *Organic Geochemistry* 34:1199-1210.

Study Investigator:

Robert A. Gleason, Research Wildlife Biologist, USGS Northern Prairie Research Center, Jamestown, ND

The U.S. Department of Agriculture (USDA) prohibits discrimination in all its programs and activities on the basis of race, color, national origin, age, disability, and where applicable, sex, marital status, familial status, parental status, religion, sexual orientation, genetic information, political beliefs, reprisal, or because all or a part of an individual's income is derived from any public assistance program. (Not all prohibited bases apply to all programs.) Persons with disabilities who require alternative means for communication of program information (Braille, large print, audiotape, etc.) should contact USDA's TARGET Center at (202) 720-2600 (voice and TDD). To file a complaint of discrimination write to USDA, Director, Office of Civil Rights, 1400 Independence Avenue, S.W., Washington, D.C. 20250-9410 or call (800) 795-3272 (voice) or (202) 720-6382 (TDD). USDA is an equal opportunity employer.