Natural Resources Conservation Service
Conservation Effects Assessment Project
Key Findings of CEAP–Wetlands Assessments

Wetlands Conservation, Water-Quality and Soil Carbon Benefits in the Glaciated Interior Plains

Voluntary, Incentives-based Wetlands Conservation Practices Can Improve Water Quality and Soil Carbon Storage. The Glaciated Interior Plains (GIP, aka "Corn Belt") is a highly productive agricultural region, where excess sediment and nutrient loads have degraded aquatic ecosystems. Historic tiling and drainage has resulted in 50 to 90% loss of regional wetland and riparian habitats, with accompanying losses in ecosystem services such as purifying water and sequestering soil carbon. These services can be recovered through the use of conservation practices such as conservation buffers and wetlands restoration, which are typically implemented under the Conservation Reserve Program (CRP) and Wetlands Reserve Program (WRP, now part of the Agricultural Conservation Easement Programs). Conservation buffers are small permanently vegetated areas or strips that provide sediment trapping and nutrient filtering between cropped lands and adjacent waterways, as well as enhanced wildlife habitat. Restored wetlands provide various benefits such as natural hydrology function and vegetated wildlife habitats within the agricultural landscape. This report highlights results from CEAP–Wetlands regional studies in the GIP that quantified two important ecosystem services: 1) water-quality improvement, as measured by denitrification and phosphorus-sorption processes, and 2) soil carbon storage.

Riparian Buffers and Wetlands Restoration in the GIP

- Riparian buffers are a common type of conservation buffer in the GIP. They may be riparian areas that are re-established by planting (typically with trees), or naturally forested riparian areas that are conserved.

- Depressional wetlands, a common wetland type, are restored by removing tile drains or blocking drainage ditches. Restored wetlands may re-vegetate naturally or can be seeded or planted. They may be managed for plant diversity and wildlife habitat.

- Two projects (Fig. 1) compared water-quality improvement processes and soil carbon storage for five land treatments: cropped lands, restored buffers, conserved (natural) buffers, restored wetlands, and natural wetlands. Key findings for denitrification, phosphorus sorption, and soil organic carbon (see Table 1) are discussed below.

Figure 1. Glaciated Interior Plains region ("Corn Belt") as delineated for CEAP–Wetlands assessments. Fifty-one wetland sites (IN - 30, OH - 21) were studied.

Riparian Buffers Enhance Nitrogen Removal

- Denitrification removes nitrogen (N) from soil water through anaerobic microbial processes that convert soluble N to nitrous oxide gas. In riparian buffers, surface runoff infiltrates and becomes part of slower subsurface flow that is more favorable for denitrification. Soil organic matter (SOM) provides a carbon source for the microbially-mediated processes.

- Restored and natural riparian buffers in the GIP had generally high denitrification rates compared to measured rates for cropped lands (Table 1). Croplands are sources of excess N, and denitrification is limited by improved soil drainage.

- Restored wetlands had lower denitrification rates than riparian buffers, in part because still-water conditions in depressional wetlands may provide less N-removal capacity than the flow-through "pulsed" hydrology that occurs in riparian buffers. If depressional wetlands become sinks for excess N, their water quality and wildlife habitat quality may be degraded.

Table 1. Mean values for water-quality functions (potential denitrification, phosphorus sorption) and carbon storage in surface soils (0-5 cm depth) of cropped lands, riparian buffers, and wetlands in the Glaciated Interior Plains (IN, OH).

Land Treatment	Denitrification (ng N/g/hr) †		P Sorption Index (mg P/kg soil)		Soil Organic Carbon (%)	
	Indiana	Ohio	Indiana	Ohio	Indiana	Ohio
Cropped Lands	–	6.3	265	–	2.2	2.4
Restored Riparian Buffers	470	**42.4**	218	189	**4.5**	3.2
Natural Riparian Buffers	528	**34.7**	205	187	**4.8**	**4.6**
Cropped Lands	–	1.4	86	–	2.4	2.8
Restored Wetlands	107	12.3	114	403	2.2	3.4
Natural Wetlands	**329**	–	**297**	–	**9.2**	**15.1***

Notes: Cropped sites were matched by location to practice type (buffers or wetlands). Means in **boldface** are significantly greater within a practice type. †Denitrification rates by state differed in assay method; *Data from an earlier study (0-10 cm depth); – indicates data not available

Wetland Restoration and Riparian Buffer Practices Can Enhance Phosphorus Removal

- Sorption processes bind phosphorus (P) to soil particles or organic matter, thus reducing P loading to adjacent waters. In wetlands, saturation and ponding promote SOM accumulation, which enhances P-sorption capacity.

- Restored and natural riparian buffers in the GIP had similar P-sorption indices of approximately 200 mg/kg (Table 1). These results suggest that restored buffers could achieve natural levels of P-sorption function in 3 to 5 years.

- Restored wetlands in Indiana had lower P-sorption indices than buffers or natural wetlands, whereas Ohio restored wetlands had high indices (403 mg/kg) (Table 1). Hydrology and vegetation management influence P sorption by affecting SOM accumulation. Restored Indiana wetlands were drier and were managed with prescribed fire, which can result in lower SOM content and P sorption. Ohio wetlands were wetter and not fire-managed.

Restored Wetlands Recover Soil Carbon Storage Slowly

- Wetlands can store substantial amounts of soil organic carbon (C) because prolonged wetness results in less plant litter decomposition and more SOM accumulation. To a lesser extent, riparian buffers also accumulate SOM and sequester more soil C than cropped lands (Table 1). Soil C storage occurs more slowly than nutrient-removal processes.

- Restored wetlands had equal or slightly higher soil organic C than cropped sites, while natural wetlands had the highest values ranging from 9–15% (Table 1). Ohio wetlands gained small amounts of soil C in 3 to 7 years after restoration, suggesting that substantially more time is needed to attain soil C storage similar to levels in natural wetlands.

- Organic C pools in the topsoil layer (0-15 cm) ranged from 2570 to 3810 g/m^2 in buffers and Ohio restored wetlands, and from 1350 to 2110 g/m^2 in Indiana wetlands. The lower Indiana values partly reflect the effects of prescribed fire management on SOM accumulation.

Wetland and Riparian Buffer Conservation Practices Bring Trade-Offs in Ecosystem Services

Wetlands and riparian buffers provide multiple ecosystem services, but not all equally. Buffer practices offer greater benefits for water-quality improvement, whereas wetland practices offer potentially greater benefits for C sequestration, depending on management regime. While prescribed fire management reduced some functions of restored wetlands, it enhanced others such as vegetation diversity and habitat quality. The benefits from these conservation practices can be optimized by recognizing the trade-offs among ecosystem services and considering where conservation practices may be best placed on the agricultural landscape to meet multiple objectives.

Full report available on the CEAP–Wetlands web page: C. Craft, S. Fennessy, and J. Marton, "Quantifying ecosystem services derived from wetland conservation practices in the Glaciated Interior Plains". March 2012.