Ecosystem Services of Restored Freshwater Wetlands of the Agricultural Midwest: Measurement & Valuation

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Wetland Services

- Nutrient (N,P) sinks and transformers
- Carbon sequestration
- Biodiversity & habitat
- Flood abatement
Wetland Loss

- More than 90% of depressional, floodplain and riparian wetlands.

- Increased nutrient loading, freshwater and coastal eutrophication and hypoxia.
Nutrient enriched stream
Coastal eutrophication
Hypoxia & fish kills
USDA Farm Bill
Wetland and Riparian Restoration

• USDA Farm Bill- Wetland Reserve Program (WRP – water quality & habitat) and Conservation Reserve Program (CRP – erosion control).

• Over 100,000 ha of WRP and CRP restoration in the Glaciated Interior Plain (GIP) since 2000.
  – Approximately 0.2% of estimated loss
Objectives

I. Do restored wetlands (and riparian buffers) provide ecosystem services (water quality improvement, C sequestration, biodiversity, greenhouse gas emissions) comparable to natural counterparts?

II. What are the economic benefits ( $$$ ) of restoring these services? ( C sequestration, N, P accumulation)
Wetland Restoration...
...means plugging ditches
10 year-old restored wetland
Riparian Restoration...
...means planting trees
4 year-old restored riparian buffer
Forested Riparian Buffer
Study Sites

Legend
- Natural Wetlands
- Natural and Restored Riparian
- Restored Wetlands

Wetlands

Riparian Buffers

Newton County

Hamilton County

Kankakee River

White River
Water Quality (Denitrification)

![Graph showing ng N₂O/g soil/hr for Wetland and Riparian areas, comparing Restored and Natural conditions.]

- Ambient vs Potential
- Restored Natural
- Wetland Riparian
- Statistical comparisons indicated by letters

Water Quality (P Sorption)

Graph showing PSI (mg P/100 g soil) for Restored and Natural Wetland Riparian soils.

- Restored: $r^2 = 0.52$
- Natural: $r^2 = 0.59$
Measurement of Carbon Sequestration

- Fallout from nuclear weapons testing
- $^{137}\text{Cs}$ marker layer
- Provides soil accretion rate, C sequestration, N,P accumulation
Soil Accretion in Natural Systems

Depressional Wetland

Floodplain Wetland

Riparian Buffer

Accretion Rate = 0.65 mm/yr

Accretion Rate = 0.65 mm/yr

Accretion Rate = 3.3 mm/year

Accretion Rate = 1.09 mm/yr
Carbon Sequestration and N, P Accumulation (Natural Systems)
Plant Biodiversity (Wetlands)
Species Richness and Floristic Quality

- **Alpha Richness, Beta Richness** (Number of Species)
- **Plot Richness** (Number of Species/1 m²)
- **Site Richness** (Number of Species/Site)
- **FQAI** ($\sum \text{CofC's}/\sqrt{N}$)

- **Floristic Quality Assessment Index**

- **Natural**
- **Restored**
Greenhouse Gas Emissions (Wetlands)
Anaerobic Incubations & Static Flux Chamber Measurements
Chamber- CH₄

CH₄ Flux (g CH₄-C ha⁻¹ day⁻¹)

Natural Wetlands
Restored Wetlands

June July Aug Sept Mean
-3
-2
-1
0
1

A
B

Natural Wetlands
Restored Wetlands
Questions

I. Do restored wetlands (and riparian buffers) provide ecosystem services (water quality improvement, C sequestration, biodiversity, greenhouse gas emissions) comparable to natural counterparts?

II. What are the economic benefits ($$) of restoring these services? (C sequestration, N, P accumulation)
# Carbon and Nutrient (N, P) Trading Credits

<table>
<thead>
<tr>
<th></th>
<th>Carbon(^1) ((\text{$ t C}))</th>
<th>Nitrogen(^2) ((\text{$ kg N}))</th>
<th>Phosphorus(^3) ((\text{$ kg P}))</th>
</tr>
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<td>Credit</td>
<td>0.18 - 33</td>
<td>21 - 97</td>
<td>313</td>
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\(^1\) Chicago Climate Exchange (CCX) - European Union (EU)

\(^2\) Ribaudo et al. 2005

\(^3\) NC Dept. of Environment and Natural Resources
$ Value of C Sequestration & N,P Accumulation

(GIP – Corn Belt)

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<th><strong>Ha Restored</strong> ¹</th>
<th>100,000</th>
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<tr>
<td><strong>Carbon ($/yr)</strong></td>
<td>900 - 163,000</td>
</tr>
<tr>
<td><strong>Nitrogen ($/yr)</strong></td>
<td>83 - 383 x 10⁶</td>
</tr>
<tr>
<td><strong>Phosphorus ($/yr)</strong></td>
<td>444 x 10⁶</td>
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¹ Since 2000.

Sequestration/accumulation calculated using the mean value of wetlands and riparian buffers.
Conclusions

• Restored wetlands contribute less to WQ improvement than natural wetlands. Restored riparian buffers are comparable to natural buffers.

• Plant biodiversity and greenhouse gas emissions are comparable in restored and natural wetlands. Emissions are low.

• Most economic valuation is linked to WQ improvement, not much to C sequestration.