Management of a natural floodplain wetland for mitigation of non-point source pollution

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Problem Statement

- Non-point source nutrient pollution is a major problem in the United States.
- Many sites exceed EPA guidelines for N and P concentrations.
- N and P pollution can dramatically alter marine ecosystems.
NPS in Mississippi

Mean Total P

0.0 0.1 1 10 100 1000 10000 100000

0.0 0.1 1 10 100 1000 10000

US EPA criteria for Delta
US EPA criteria for Hills

Mean Total N (mg/L)

0.1 1

0.1 1

Drainage Area (km²)
Hypothesis

• NPS pollution can be trapped and processed by natural wetland
• Riverine wetland receives water from runoff and river overflow
Site Description

• 500 m long severed meander bend of the Coldwater River in Tunica County, MS
• 2 main inputs: drainage pipe & connection with river
• Two weirs constructed during restoration
• Wetland cell and lake cell created
Drainage Structure Operation

- Weir boards removed on 12/1
- Weir boards replaced on 3/1
Wetland Conditions Time Series

**pH**

**DO, mg/L**
Wetland Conditions Time Series

![Graph showing pH and DO levels over time from 7/8/08 to 7/13/08]
Methods - Data Collection

- ISCO 2150 Area Velocity Flow Module in drainage pipe
- Onset Water Level Recorders in wetland, lake, and river
- Weekly grab samples from all sites
Methods-Water Budget

Evaporation

Flow through drainage structure

Lake

Over weir flow

UPSS Wetland

DS Wetland

Flow through drainage structure

Coldwater River

Over weir flow

Runoff from fields—tributary slough
Methods-Water Budget

\[ \frac{\Delta S}{\Delta t} = Q_{\text{evap}}(t) + Q_{\text{pipe}}(t) + Q_{\text{drainw}}(t) + Q_{\text{drainl}}(t) + Q_{\text{stonew}}(t) + Q_{\text{stonel}}(t) \]

• Balance \( \Delta S \) with inflows and outflows during each time step
• Flow over weirs can be either critical or normal
• Nonlinear regression used to adjust coefficients and exponents for weir flow formulas
• Nutrient loads calculated
Concentrations

Total Phosphorous

Concentration, mg/L

Fields

Wetland

Total Nitrogen

Concentration, mg/L

Fields

Wetland

Suspended Sediment

Concentration, mg/L

Fields

Wetland
Wetland Water Budget, (millions of m³)

Lake

±0

Coldwater River

.173

.053

.0006

1.02

Fields

.908
Wetland SS Budget

Lake:
13187 kg
3297 kg

-24692 kg
18%

Coldwater River:
86 kg
107868 kg

Fields:
122584 kg
Wetland TP Budget

Lake

99 kg

Coldwater River

0.4 kg

-385 kg

29%

Fields

1229 kg

29 kg

916 kg
Wetland FP Budget

Lake

-102 kg

34%

Coldwater River

187 kg

0.1 kg

Fields

272 kg

25 kg

9 kg
Wetland NO$_3$ Budget

21 kg  \rightarrow \text{Lake} \rightarrow -131 \text{ kg} \rightarrow \text{Coldwater River} \rightarrow 164 \text{ kg}

\leftarrow 9 \text{ kg} \leftarrow 0.1 \text{ kg}

\uparrow \text{Fields} \uparrow 284 \text{ kg}
Wetland TN Budget

425 kg → Lake → -708 kg → Coldwater River → 2194 kg
75 kg ← Lake

Fields
2551 kg
Monthly Net Flux

**Net flux of water, 1000 m³**

**Net Flux of SS, kg**

**Net Flux of TN, kg**

**Net Flux of TP, kg**
Monthly Net Flux, cont.

Net flux of water, 1000 m³

Net Flux of FP, kg

Net Flux of NH₃, kg

Net Flux of NO₃, kg
% Nutrient Retention vs Net Flux of Water

Retention 125%

Retention 75%

Retention 25%

Retention 75%

Export 125%

Export -125%

Net flux of water, m³

% Retention

Export

Retention

TN

TP

-125%

-150

-50

50

150
Conclusions

• Nutrient pollution from agricultural runoff is a problem globally, nationally, and locally.
• With the exception of NO$_3$, the wetland proved effective in reducing concentrations of pollutants.
• The wetland significantly reduced overall loads of all parameters.
• Wetland performs best in drier periods, when retention time is increased.
• More work is needed to assess performance during periods of intense interaction with the river.