Phosphorus Transport in Wetlands

Murthy Kasi
North Dakota State University
09/23/03
Outline

- Introduction
- Research Goal & Objectives
- Study Area
- Field Methods
- Results & Discussion
- Summary & Future work
Introduction

- Wetlands in Prairie Pothole Region (PPR) in North America known to support diverse species of biota, regulate flooding, control water quality, and recharge groundwater
- About 50% of these wetlands are lost
- Restoration efforts by state and federal agencies are in progress
Introduction Contd.,

- Evaluate restoration using measurements such as
  - nutrients, vegetation, fish and wildlife
- Present research interested in water quality in wetlands; and nutrients chosen as measurement to evaluate restoration
- Phosphorus chosen for study
  - because, among nutrients, phosphorus major limiting nutrient
Research Scope & Objectives

- **Goal**
  - Study phosphorus transport within various wetland components (soil, water and biota)

- **Objectives**
  - Determine phosphorus forms and concentrations in wetland water, soil, and plants
  - Study the variations in phosphorus concentrations with space and time in wetland water column
- Study water quality changes with space and time in the selected wetlands
- Determine the factors contribute to phosphorus transformations in wetland components
Study Location

- Hamden Slough National Wildlife Refuge (NWR), located in Buffalo Red River watershed, Becker County, Minnesota
- Almost 100% of all wetlands in the refuge have been drained for agricultural activities
- Migratory Bird Conservation Commission approved Hamden Slough NWR as the 452nd refuge in 1989 to restore lost wetlands
Study area

Becker County

Hass Wetlands

Bisson Wetlands

Project sampling locations

Minnesota
Present condition

- High phosphorus levels in soil and water in restored and excavated wetlands
- High phosphorus levels in Lake Bisson (much greater than 100 µg/L of total phosphorus, which can lead to eutrophication (USEPA, 2000))
Selected Wetlands

- Bisson Wetlands
  - wetlands 112, 113 and 110

- Hass wetlands
  - Wetlands 35, 38, 38a, 41a, 41b and 41
Hass Wetlands

35 38 38a

41b 41a

41

County Road 14

N
Field Methods

- Water sampling
  - Water Sampling done monthly once starting from May through August for 3 years (2001 (June only), 2002, 2003)
  - Sampling locations - on the ends of each wetland in the direction of flow
  - Sample analysis
    - pH, total phosphorus, orthophosphate, $\text{HCO}_3^-$, $\text{CO}_3^-$, $\text{Cl}^-$, $\text{Fe}^{+2}$, $\text{Mn}^{+2}$, Ca, and Mg
- Soil sampling
  - Samples collected only once (June 2001)
  - Sampling locations are at approximately 20’ distance from each other
  - Samples collected at 18” deep for profiling

- Sample analysis
  - P, K, Fe, Mn, Ca, Mg, Na, pH, EC, Organic matter and Cation exchange capacity
Results & Discussion
Total Phosphorus changes in Bisson Wetlands

<table>
<thead>
<tr>
<th>May-02</th>
<th>Jun-02</th>
<th>Jul-02</th>
<th>Aug-02</th>
<th>May-03</th>
<th>Jun-03</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Concentration (mg/L)
pH Changes in Bisson wetlands

May-02
Jun-02
Jul-02
Aug-02
May-03
Jun-03

Lake Bisson

pH
Calcium Changes in Bisson wetlands

May-02
Jun-02
Jul-02
Aug-02
May-03
Jun-03

Ca, mg/L

Lake Bisson

112N 112S 113N 113S 110N 110S

Calcium Changes in Bisson wetlands

May-02
Jun-02
Jul-02
Aug-02
May-03
Jun-03
Temperature effects on total phosphorus in wetland112N

Temperature (°C)

Total phosphorus (mg/L)

Temperatures: 6.5, 9.5, 12.5, 15.5, 18.5, 21.5, 24.5

Phosphorus concentrations: 0.05, 0.1, 0.15, 0.2, 0.25, 0.3

Graph shows the relationship between temperature and total phosphorus concentration.
Discussion

- Increase in orthophosphate levels at north end of each wetland due to reduced conditions
- Increase in total phosphorus levels at north end of each wetland
- Temperature has significant effect on pH and total phosphorus
- High pH conditions favorable for Calcium phosphate (apatite) formation
Total Phosphorus changes in Hass Wetlands

May-02
Jun-02
Jul-02
Aug-02
May-03
Jun-03

Concentration (mg/L)
Total Phosphorus changes in Hass Wetlands
Orthophosphate changes in Hass Wetlands
Calcium changes in Hass Wetlands

- Concentration (mg/L)
- May-02, Jun-02, Jul-02, Aug-02, May-03, Jun-03

Locations:
- 41aE, 41aW, 41bN, 41bS
Calcium changes in Hass Wetlands

Concentration (mg/L)

May-02
Jun-02
Jul-02
Aug-02
Jun-03
May-03
pH changes in Hass Wetlands

Concentration (mg/L)

May-02
Jun-02
Jul-02
Aug-02
May-03
Jun-03
pH changes in Hass Wetlands
Results

- Calcium levels decreased with time in wetlands 41a and 41b; where as increased in 35, 38, and 38a

- Orthophosphate levels decreased and increased in alternative months in an year in wetlands 35, 38 and 38a; where increased in consecutive months and decreased in next months
Summary and Future work

- Different changes in TP and OP with time in different wetlands
- Modeling would help understand the dynamics better
Acknowledgements

- ND Water Resources Research Institute
- Mike Murphy, Refuge Manager, Hamden Slough NWR
- Dr. Wei Lin, Advisor
- Dr. G. Padmanabhan, Professor, Department of Civil Engineering, NDSU
- Dr. Richardson, Chair, Soil Science Department, NDSU